

North Carolina State Library





Digitized by the Internet Archive
in 2014



Some of the Engineers who attended the Good Roads Institute at the University of North Carolina, March 17, 18 and 19, 1914.

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

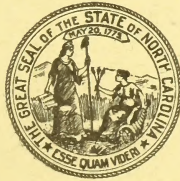
ECONOMIC PAPER No. 39

PROCEEDINGS
OF THE
GOOD ROADS INSTITUTE

HELD AT THE
UNIVERSITY OF NORTH CAROLINA

MARCH 17-19, 1914

*Held under the Auspices of the Departments of Civil and
Highway Engineering of the University of North Carolina and
The North Carolina Geological and Economic Survey*



RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
STATE PRINTERS
1914

N 557
N 813
39

GEOLOGICAL BOARD

GOVERNOR LOCKE CRAIG, *ex officio* Chairman.....Raleigh.
FRANK R. HEWITT.....Asheville.
HUGH MACRAE Wilmington.
HENRY E. FRIES.....Winston-Salem.
W. H. WILLIAMSON.....Raleigh.

JOSEPH HYDE PRATT, *State Geologist*.....Chapel Hill.

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., November 1, 1914.

*To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.*

SIR:—There was held in March of this year, at the University of North Carolina, under the auspices of the State University and the North Carolina Geological and Economic Survey, a Good Roads Institute, which proved to be of so much interest to those who attended that I believe the proceedings of this Institute should be put in such shape so that they can be distributed to the road engineers and superintendents of the State. I have, therefore, had the proceedings compiled and herewith submit them for publication as Economic Paper No. 39 of the publications of the North Carolina Geological and Economic Survey.

Very respectfully,

JOSEPH HYDE PRATT,
State Geologist.

CONTENTS

	PAGE
Introduction.....	9
Proceedings of the Institute.....	11
Program	11
Resolutions	13
Consideration Governing the Proper Location of Roads, by D. Tucker Brown	13
Road Surveying and Mapping, by T. F. Hickerson.....	19
The Use of the Abney Hand Level, by T. F. Hickerson.....	26
Economics of Road Construction, by W. S. Fallis.....	31
Sand-clay and Topsoil Roads the Economic Roads for North Carolina, by Joseph Hyde Pratt.....	35
Natural Sand-clays in the North Carolina Piedmont Belt, by John E. Smith.....	42
Dirt Roads, by Joseph Hyde Pratt.....	45
Drainage of Roads, by T. F. Hickerson.....	48
County Highway Bridges, by J. M. Ambler.....	49
Culverts, by R. T. Brown.....	56
Road Machinery Required in County Road Construction, by N. C. Hughes, Jr.....	63
Road Surfacing Materials in North Carolina, by Prof. Collier Cobb	68
Lignin Liquor as a Binder for Macadam, Gravel, and Sand-clay Roads, by Geo. N. Moore.....	70
Forms of Contract for Roads Used by Commissioners of Greene County, Tenn.	74
Form of Contract Used by Orange County Good Road Com- mission	85
Blanks Used in Iredell County.....	93
Forms Used by Vance County Road Commission.....	100
Forms Used in Alabama State Aid Work.....	103
Eight Bids Submitted on Contract Work in Greene County, Tenn., in 1913.....	110
Publications of the North Carolina Geological and Economic Survey..	111

ILLUSTRATIONS

PLATE	FACING PAGE
I. Some of the Engineers who attended the Good Roads Institute at the University of North Carolina, March 17, 18 and 19, 1914.	<i>Frontispiece</i>
II. A. Dirt road that could be improved 100 per cent by use of split-log drag	45
B. Road with steep grades (average 10 per cent). Travel made more difficult by uneven surface of road; large stones project above road	45
III. A. Surface ditch in dirt road for carrying water from one side to another. This ditch should not be used, and the water should be carried under the surface by means of a culvert....	46
B. Road where surface contains a great many stumps. Such a road cannot be maintained properly.....	46
IV. A. Old way of throwing dirt from ditches on side of road, preventing drainage from road into ditch. This scene is in Craven County	47
B. Wayne County farmer using the public road for a turning place for cultivator, thereby damaging the road.....	47
FIG.	PAGE
1. Diagram	18
2. "	20
3. "	20
4. "	21
5. "	22
6. "	24
7. "	24
8. Abney Hand Level.....	26
9. Diagram	27
10. "	28
11. "	28
12. "	29
13. "	29
14. "	30
15. Sketches of Headwalls for Pipe Culverts.....	62

PROCEEDINGS
OF
Good Roads Institute
HELD AT
UNIVERSITY OF NORTH CAROLINA
March 17-19, 1914

INTRODUCTION.

There was inaugurated at the University of North Carolina, March, 1914, an Institute that will probably become one of the more important phases of the extension work organized by the University. This refers to the Good Roads Institute held on March 17, 18, and 19, 1914, under the auspices of the Department of Civil and Highway Engineering of the University and the Highway Division of the North Carolina Geological and Economic Survey.

The object of the Institute was to bring together at the University the engineers and superintendents who have the direct charge of the road work throughout the different counties in North Carolina for a discussion of the various road problems and for consultation regarding peculiar road problems that the different men have to consider. Invitations were sent to engineers and superintendents of all the counties and the boards of county or road commissioners, by whom these men are employed, were urged to instruct them to attend the Institute and that their attendance be considered part of their official duties. In some instances this was done and the counties bore all the expenses of the engineers and superintendents to the Institute. It is believed that this Institute, as it is made an annual occurrence, will become a clearing-house for road problems in this State.

Although the attendance at this first Good Roads Institute was not large the men were from many different sections of North Carolina and were a representative body of those in charge of the road work of the State. There were fifty-four registered at the Institute from the following twenty-four counties:

Cabarrus
Cleveland
Craven
Davidson
Duplin
Durham
Edgecombe
Forsyth

Guilford
Halifax
Iredell
Madison
McDowell
Mecklenburg
New Hanover
Northampton

Orange
Robeson
Rockingham
Rowan
Rutherford
Scotland
Vance
Wake

Before the close of the Institute, those attending passed a strong resolution, urging the University and the Survey to make it an annual affair, and, in accordance with this request, the officials of these two institutions have arranged for holding a Good Roads Institute annually at the University of North Carolina. The scope and efforts of the Institute will be enlarged, and it is expected that in 1915 the Institute will be of at least a week's duration.

Many valuable papers were presented at the Institute that make a valuable addition to good roads literature, and these papers, as far as possible, are published at the end of the report of the proceedings of the Institute.

In arranging the program it was realized that certain rules and regulations would have to be in vogue similar as in regular university work. The lectures began promptly at the hour designated and the Institute was enabled to carry out the program almost in its entirety.

The following are the names of those who registered at the Road Institute:

- John M. Ambler, Highway Engineer, Winston-Salem, N. C.
- A. H. Carr, Durham, N. C.
- George M. Carson, Road Superintendent, Marion Township, Marion, N. C.
- J. B. Clingman, Road Engineer, Madison County, Marshall, N. C.
- Collier Cobb, Jr., Chapel Hill, N. C.
- A. E. Croom, Road Foreman, Wallace, N. C.
- E. C. Belvin, Highway Engineer, Durham, N. C.
- W. A. Broadway, Mooresboro, N. C.
- D. Tucker Brown, Highway Engineer N. C. Geological and Economic Survey, Chapel Hill, N. C.
- R. T. Brown, Highway Engineer and Superintendent, Orange County, Hillsboro, N. C.
- R. A. Burnett, Road Superintendent, New Hanover County, Wilmington, N. C.
- J. A. Davidson, County Superintendent, Greensboro, N. C.
- S. B. Dameron, Reidsville, N. C.
- Brent S. Drane, Engineer, Charlotte, N. C.
- W. P. Eddleman, County Superintendent, Shelby, N. C.
- W. S. Fallis, Highway Engineer, Franklinton, N. C.
- B. L. Field, Chapel Hill, N. C.
- G. W. Flowers, Durham, N. C.
- A. P. Gilbert, representing Galion Iron Works, Durham, N. C.
- H. W. Harkey, Charlotte, N. C.
- T. F. Hickerson, Highway Engineer, Chapel Hill, N. C.
- N. C. Hughes, Jr., Highway Engineer, Weldon, N. C.
- T. P. Jenkins, Road Superintendent, Tarboro, N. C.
- F. Swindell Kluttz, Concord, N. C.
- R. L. Lasley, Wentworth, N. C.
- E. W. Lupton, Chapel Hill, N. C.
- Lee W. Lynch, Highway Engineer, Forest City, N. C.
- L. H. Lyon, Wilmington, N. C.
- M. G. Markham, County Commissioner, Durham, N. C.

- F. H. May, Wendell, N. C.
 J. S. Miller, Jr., Philadelphia, Pa. Barber Asphalt Co.
 George N. Moore, representing Robeson Process Company, Pennington, N. J.
 Ira B. Mullis, Highway Engineer, Lumberton, N. C.
 B. McAllister, Wilmington, N. C.
 R. A. Patterson, Salisbury Metal Culvert Co., Salisbury, N. C.
 J. L. Phillips, Assistant Engineer, Orange County, Hillsboro, N. C.
 J. T. Plott, Statesville, N. C.
 J. M. Pollard, Superintendent of Roads, Durham County, Durham, N. C.
 Joseph Hyde Pratt, Chapel Hill, N. C.
 James B. Price, Superintendent of Roads, Rockingham County, Madison, N. C.
 A. A. Reed, Chapel Hill, N. C.
 R. A. Reed, Winston-Salem, N. C.
 C. S. Reeve, U. S. Office of Public Roads, Washington, D. C.
 J. T. Rogers, County Commissioner, Durham, N. C.
 C. L. Sapp, Road Engineer, Rich Square, N. C.
 J. B. Scarborough, Chapel Hill, N. C.
 G. A. Simpson, Laurel Hill, N. C.
 J. H. Slaughter, representing Harry Bros. Co., Lexington, N. C.
 Q. E. Smith, Highway Commissioner, Concord, N. C.
 R. E. Snowden, Highway Engineer, New Bern, N. C.
 — — Sumwalt, Dixie Culvert Co., Greensboro, N. C.
 W. M. Ward, Newton, Iowa.
 F. F. Wetmore, Highway Engineer, Lumberton, N. C.
 W. Staley Wicker, Chapel Hill, N. C.
 J. E. Wright, Road Superintendent, Laurinburg, N. C.

PROCEEDINGS OF THE INSTITUTE

The Good Roads Institute was called to order by the State Geologist in the auditorium of the Peabody Building, at nine o'clock Tuesday morning, March 17, 1914. The members of the Institute were welcomed to the University by Acting President Edward K. Graham, in his usual happy vein. He stated that it is the University's purpose to serve the State in every way leading to its upbuilding and the promotion of the welfare and happiness of its people; that few people were rendering the State a greater or more faithful service than the road engineers, and the University feels honored in welcoming them to her doors.

After the address of Mr. Graham the following program was carried out:

PROGRAM.

TUESDAY, MARCH 17, 1914.

- 9:15 a. m. General Principles of Road Location, Prof. Wm. Cain.
 9:30 a. m. Practical Considerations Governing the Location of Roads, D. Tucker Brown, Road Organizer and Engineer of the North Carolina Good Roads Association.
 Discussion.

- 10:30 a. m. Road Surveying and Mapping, Prof. T. F. Hickerson.
Discussion.
- 12:00 m. Practical Demonstration of the Abney Hand Level, Professor
T. F. Hickerson.
- 2:30 p. m. The Economics of Road Construction, W. S. Fallis, Road En-
gineer.
- 7:30 p. m. Lecture on "Asphalt from its Source to the Pavement," (illus-
trated with moving pictures), J. S. Miller, Jr.

WEDNESDAY, MARCH 18, 1914.

Surfaced Roads

- 8:30 a. m. Sand-clay, Topsoil and Gravel Roads, Joseph Hyde Pratt, State
Geologist.
Discussion.
- 10:00 a. m. Waterbound and Bituminous Macadam Roads (illustrated), Mr.
C. S. Reeve of the U. S. Office of Public Roads.
Discussion.
- 11:30 a. m. Dirt Roads, Joseph Hyde Pratt.
Discussion.

Drainage of Roads.

- 2:30 p. m. Drainage of Roads, T. F. Hickerson.
- 3:00 p. m. County Bridges, Jno. M. Ambler, Road Engineer.
- 3:30 p. m. Culverts, R. T. Brown, Road Engineer.
Discussion.
- 4:00 p. m. Demonstration of Use of Road Drag, R. T. Brown, Road Engi-
neer.
- 7:30 p. m. Good Roads in Foreign Lands (illustrated), Professor Collier
Cobb.

THURSDAY, MARCH 19, 1914.

Road Machinery and Supplies.

- 8:30 a. m. Road Building Machinery, N. C. Hughes, Jr.
Discussion.
- 9:30 a. m. Road Surfacing Materials in North Carolina. Professor Collier
Cobb.
- 10:00 a. m. Maintenance of Roads, R. A. Burnett, Road Superintendent.
Discussion.
- 11:00 a. m. Organization of Road Forces, Prof. M. H. Stacy.
Discussion.
- 12:00 m. The Road Contractor, Brent Drane.
- 12:30 p. m. Natural Sand-clays in North Carolina Piedmont Belt, by Mr.
John E. Smith.
- 2:30 p. m. Visitors shown over the University Buildings.

There were excellent discussions of nearly all the papers presented and the general feeling of those in attendance was that the Institute was a success and would be very beneficial in the public road work of North Carolina.

During the morning session on Thursday, March 19th, the following resolutions were introduced and unanimously passed:

Resolutions.

I. *Resolved*, That we express our thanks and appreciation to the Departments of Civil and Highway Engineering of the University and the North Carolina Geological and Economic Survey for the benefits which we have derived from the Good Roads Institute.

II. *Resolved, further*, That it is our belief that such an Institute is of very great value to the good roads work of North Carolina, and it is also our belief and desire that the Institute be made an annual occurrence, and we herewith respectfully request the President of the University and the Director of the North Carolina Geological and Economic Survey that they seriously consider the holding of an annual Good Roads Institute at the University.

There are given on the following pages the papers read at the Institute and other data and information submitted by the different members in attendance.

Considerations Governing the Proper Location of Roads.

BY D. TUCKER BROWN, ORGANIZER AND ENGINEER OF THE NORTH CAROLINA GOOD ROADS ASSOCIATION.

The proper location of a road consists in determining and marking out those points on the ground through which the road should pass in order to satisfy as nearly as possible the requirements of an ideal road.

These requirements for an ideal road may be divided into two groups:

- (1) Those which make a road perfect from a technical standpoint; and
- (2) Those which make a road perfect from the standpoint of serviceability to the country, both in regard to local and through traffic.

A section of the country is seldom found in which the requirements of both groups may be satisfied, and as there are certain limits to each, those of the first being more definite and important, it is essential that they be more carefully observed.

Upon the first group depends the cost of construction, maintenance and transportation; upon the second, depends the convenience to the community, and it will be readily seen that the effect of observing the first will be lasting while that of the second will be only temporary, if there is the proper development in the section through which the road passes.

In the first group these requirements for an ideal road are:

- (1) As to direction: that it should be straight.
- (2) As to grade: that it should be level.
- (3) As to cost: that the amount of work on grading, draining, mechanical structures, and surfacing should be the *least* that will make the road what it ought to be.
- (4) As to exposure: that it should have the best.

Those of the second group are:

- (1) That it should be of equal benefit to all.
- (2) That it should shorten the distance from every man's house to the point where he wishes to go.
- (3) That it should run through every man's land where he thinks it should.
- (4) That it should shorten the distance between communities and markets.

It is evident, that to satisfy the requirements of the first group it is necessary that the ground between the termini of the road be a straight level ridge with adequate drainage to either side and sufficient exposure to the sun, and that this condition is rarely ever met with in practice, and certainly not on roads of any great length. The country is usually so broken by mountains and valleys, hills and vales, as to present great difficulties to securing a location which will even approach the ideal, and the question which confronts the locating engineer is how to secure the best route that the topography of the country will permit, without sacrificing to too great an extent any of the requirements for an ideal road; and to enable him to accomplish this it is necessary that he have a general knowledge of those features of the earth's surface which govern the location of roads, and a more thorough knowledge of the topography of the country immediately adjacent to the proposed route.

I think it an undisputed fact that:

- (1) Hills are the natural enemies to the road maker; and
- (2) Water courses his guides and assistants.

It is, therefore, essential that he study their relations to one another, and the advantages and disadvantages which they present; and, in this connection, the following facts will be of inestimable value:

- (1) If a principal ridge is met by two secondary ridges at the same point, that point is of maximum height.
- (2) If a principal ridge is met by two valleys at the same point, that point is of minimum height.
- (3) If a principal ridge is met by a secondary ridge and a valley, nothing can be inferred.
- (4) If two parallel streams with a ridge between suddenly diverge, the ridge between will be found to increase in height.
- (5) If two parallel streams with a ridge between suddenly converge, the ridge between will be found to decrease in height.

For the purpose of determining the proper route through any section of country, so far as the requirements of group I are concerned, it is customary to proceed in the following manner:

A reconnaissance survey should be made of the region through which the road is to pass, and is generally made by the eye alone, without instruments. It is intended to be only approximate, and to serve to determine through what points routes should be instrumentally surveyed; and no time or labor should be spared in these first explorations, as they will save much expense in subsequent detailed surveys.

Governing points will be found through which the road must pass, such as a low gap in a range, a narrow part of a river suitable for a bridge, etc., and between these ruling points the straight line joining them is marked out on a map and the routes adopted for instrumental surveys must continually tend to coincide with it, except when deflected to the right or left by weighty reasons, such as the topography of the country demands.

If a topographical map is at hand it will be of great assistance, and the facts mentioned heretofore relative to hills and water courses will enable one to read the map more readily and accurately; and it is not infrequent that sufficient information may be obtained from it to enable one to decide what routes are the best to survey with the instruments.

After having studied carefully the topographical features of all routes and decided upon the ones to be surveyed with instruments, the next step consists in making the actual detail surveys. There may be necessary only one, and again as many as five, depending entirely upon how many routes meet so nearly the requirements as to make it impossible to decide upon the proper one without more specific information than can be obtained by a reconnaissance survey.

These surveys, in order that they may be complete, should consist of a transit line, level line, cross section notes, classification notes, topographical notes and notes on all conditions which may in any way affect the construction or maintenance of the road, and from the information obtained, the maps, profiles and estimates should be made.

After the surveys are complete, the work is in the correct form to enable one to determine which of the surveys is the best, as to alignment, grades, cost and exposure, and in general the following limits should be carefully observed on roads which are to be permanently improved.

The radius of no curve should be less than 100 feet, and if less the roadway should be widened throughout the length of the curve.

No grade should be less than 1 per cent nor greater than $4\frac{1}{2}$ per cent. Grades between these limits provide ample drainage and there is little danger of wash due to the swiftly flowing surface waters.

The cost of construction of a road should be governed entirely by the saving made possible by any form of improvement.

If possible, try to keep roads off of northern and western slopes of mountains, and if it is necessary to locate on those slopes, always try to have light grades, for if you do not, the snow and ice will be a continual menace during winter months.

Road location can therefore be summed up as follows so far as alignment, grades, costs and exposures are concerned:

To what extent may any one requirement of group I be sacrificed in order that one or more of the others of group I may be more nearly satisfied, and the proposed location still remain within the limits of economy so far as the road as a whole is concerned? And the answer is, that if the alteration of any requirement increases the sum of the costs of construction, of maintenance, and of transportation above what it was before the change; then the change is unwarranted, and vice versa.

With the surveys spoken of heretofore completed, the cost of construction can be estimated very closely; but to determine the costs of maintenance and transportation, it is essential that a traffic census be taken.

This consists of an estimate from actual observation, if an old road is to be improved; and of approximations based upon the traffic that would be benefited, if a new road is to be opened; of the tonnage, number and class of teams which do or may be expected without much doubt to pass over the road in a specified length of time, and it must be remembered that the traffic on a road will be materially increased by any form of improvement that will reduce the cost of hauling.

After estimating the traffic we are in a position to determine the costs of maintenance and transportation on any class of road for that amount of traffic and are also able to tell whether or not any contemplated improvement is a good investment and if not, what improvement would be?

In this connection, I will say that any improvement by which the interest on the money spent for construction plus the cost of maintenance and transportation is reduced should be undertaken without delay.

To demonstrate, suppose it was proposed to make a sand-clay road of an old earth road 10 miles long and that the following assumptions were true:

	<i>Earth.</i>	<i>Sand-clay.</i>
Six per cent interest on original cost one year	\$180.00	\$720.00
Cost of maintenance one year.....	250.00	800.00
Cost of transporting per year 20 tons per day at 10 cents per ton mile on sand-clay; 30 cents per ton mile on earth.....	21,900.00	7,300.00
	\$22,330.00	\$8,820.00

It will be readily seen that a community could easily afford to spend the difference between \$22,330 and \$8,820, or \$13,510 in improving the road for a traffic of 20 tons per day; and this does not take into account the possible development along the road after its improvement.

I now come to the consideration of the effect which the requirements of Group 2 should have on those of Group 1.

The requirements of Group 2 we can *never* hope to satisfy, for in each locality there are not only physical impossibilities but human impossibilities, and to carry out suggestions of those who have never seen a properly located road, but *know* every essential detail, would require the performance of miracles. I, therefore, feel a delicacy in dealing with Group 2. There are always so many people who can tell you the cheapest, shortest and most level route, and it is peculiar to note that their idea of the best route is the one which passes through their land where they wish it; that is, if they want the road, and misses their land entirely, if they do not want it.

The effect of satisfying local communities or parties so often necessitates a sacrifice of some one of the essential requirements of Group 1 and in consequence burdens the community with a road either costly in construction or maintenance, and I think it is a condition seldom found that we can afford to build a road connecting important points and sacrifice to any great extent its alignment, its grades, its cost, or its exposure, for even a rather thickly settled community. It is far better that less expensive roads be built from the main roads into such communities.

It may be well to note here, and it is a good point to bear in mind, when making locations, that a great deal of trouble with people may be avoided so far as right of way is concerned, if you find out before you run your line just where they wish it located. It frequently happens that through a man's land are two routes equally as good and his choice may be one of them, and the other may be just what he doesn't want. Furthermore, if you find out that the route you *do not* want is the one he *doesn't* want, survey it, and by so doing you can usually obtain the proper one without right of way cost.

I feel that we will never get a road where it will remain within the economic limits of the requirements of the first group, and satisfy to a great extent those of the second group, until we have the proper road laws, an absence of politics in road questions, and citizens who are willing to leave their road problems to those who have studied them.

However, I shall say a few words which I hope will be a help toward enlightening the people to the fact that good roads are money well invested, and how far they can afford to sacrifice the requirements of Group I for those of Group 2.

The question which is of paramount importance in making location in so far as the requirements of Group 2 are concerned is:

Which route (if several are considered) will be of the most benefit to the most people?

The customary answer among the laymen is: The route which passes the most homes.

I most emphatically insist that this answer is absolutely wrong and in answering the question will say that no change which increases the cost of construction or maintenance of any road should be made for the benefit of any person or persons, unless the increase in tonnage due to such change, is so great as to make the difference between the cost of hauling it over the unimproved and the improved road, greater than the interest on the additional cost of construction, plus the increased maintenance cost, plus the increased cost of transporting through tonnage over the additional section of improved road. For demonstration, suppose it is proposed to build a road between two towns or thickly settled communities which I will designate as A and B, and that the distance from A to B is D miles; also that at some point C not on the direct line from A to B there is another thickly settled community, and to go by C would increase the length of the road from D to E mile. Suppose further that the tonnage from A to B is T ton per year, that from A to C is T¹ tons per year, and from B to C is T² tons per year and that for simplicity the cost per mile for either route is N dollars and the maintenance cost for either route per mile per year is M dollars, that R is the usual rate of interest and X the cost of hauling per ton mile on improved road and Y cost on unimproved road.

Then if $EY (T^1+T^2) - EX (T^1+T^2) > (NE-ND) R + (ME-MD) + (TE-TD)X$, the route by C is justifiable and vice versa.

It must be remembered in making the foregoing deductions that a very comprehensive traffic census is necessary, and that the growth of traffic should be most carefully approximated. The same principle will apply to any routes of equal length where the difference in cost of construction, transportation and maintenance is due to excessive grades; and should a case of this kind arise, it will be well to be *most* careful in the estimate of the cost of maintenance, which increases very rapidly and *not* in proportion to the increase in grade.

I have not in the above taken into consideration the people who might have been benefited had they not been at A, B, or C, but at some intermediate point; the principle is the same, however.

It might be well to show here a method of determining the region over which the benefits of a good road would extend.

In Fig. 1, let A B represent a portion of an improved road, lying between the two points A B at which cross roads come in. It is required to fix the points C C D D so that lines drawn from C and C to A, and from D and D to B, shall define this tributary area. BC or AD is to be found in terms of AB.

The ratio of improvement of the new road compared with the old, we will say is 2; i. e., it costs one-half as much to haul over improved as it does

over unimproved. If then, $X \text{ plus } \frac{n}{2}$ is less than M, it will cost less to make

the circuit from C to A through B than over an unimproved road direct from C to A; and the cost of transportation on both routes will be equal when

$$X + \frac{n}{2} = M.$$

But in A. B. C.

$$M = (X^2 \text{ plus } N^2)$$

Substituting

$$X \text{ plus } \frac{n}{2} = (X^2 + N^2)$$

Whence we obtain the value $X = \frac{3}{4}N$.

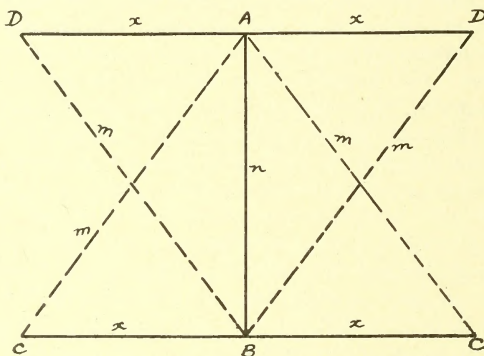


FIGURE 1.

Therefore from A and B set off at right angles to AB, BC, and AD each equal to $\frac{3}{4}$ AB, join AC and BD; and the area included will be that within which it would cost less for the inhabitants to use the improved road, though with increased distance, than to pursue the direct but unimproved road.*

It is to be regretted that our people have not realized the necessity of a traffic census on all roads which they contemplate improving permanently.

In conclusion, I shall call your attention to several points which, if borne in mind, will be of assistance to you in making locations.

- (1) When possible cross streams at narrow points and at right angles.
- (2) Make openings for all streams amply large.
- (3) When following or crossing a stream be *sure* that your grade line is well above high water.
- (4) If necessary to ford a stream, do so at a point where the least length of road will be subject to overflow.

*LeCount, Treatise on Railways.

(5) Make your stream crossings as well as gaps governing points in your survey.

(6) Cross streams where you can secure solid foundations.

(7) Generally speaking, when crossing a ridge parallel to a stream, ascend down stream and descend up stream. This will shorten your line.

(8) Compensate for curves on maximum grades.

(9) When following streams the least expensive line is usually the one just above high water line.

(10) It is economy practically in all cases to cross a ridge at its lowest point.

(11) The æsthetic features should receive consideration but not at the expense of the serviceability of the road.

(12) Above all things, if you are ever called upon to locate a mountainous road, *always* go to the gap and work down on the proper grade to the stream below.

ROAD SURVEYING AND MAPPING.

By T. F. HICKERSON, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NORTH CAROLINA.

The complete and thorough survey for a road includes in general, three engineering operations: (1) The reconnaissance; (2) the preliminary survey; (3) the final location.

The reconnaissance is a general and somewhat hasty examination of the country through which the road is to pass, for the purpose of acquiring a mental picture of the "lay of the land" and noting the *governing points* of the probable route, such as best crossings of streams, or ridges, and any point where the line will be compelled to pass.

The following instruments may be useful: barometer, hand level, pocket compass, and pedometer. A map of the territory, especially a United States Topographic map, will always be helpful.

The preliminary survey consists of an instrumental examination of the country along the proposed route for the purpose of obtaining such details of directions, distances, elevations, topography, etc., as may be necessary to prepare a map and profile of the route, make an approximate estimate of the cost of constructing the road, and furnish the data from which to definitely locate the line should the route be adopted.

The survey is more or less elaborate according to circumstances. No general rule for the exact order of procedure in every case can be given. In mountainous country where grade is the primary consideration, the first step in the preliminary survey would probably be a lay out of the center line on a certain grade by means of an Abney hand level or the gradienter attachment on a transit; then a survey with the transit and level is made. In flat country where alignment is the primary consideration, a transit survey for directions is the first step.

In many cases the route is definite enough to warrant laying out the curves while making the preliminary survey (or else making proper allowances for them in the stationing), thus obviating the necessity of the final location survey. A strong point in favor of this is that the profile of the center line will then be continuous. There is a temptation, however, to do this too often and much time is wasted in making future changes in the accurately located line or else too many short curves are used. Thus, the three curves ab, bc, and cd (Fig. 2) might have been laid out when, if a map had been made of the

transit line, a single ABC could have been selected to fit the conditions of the ground and give much better alignment.

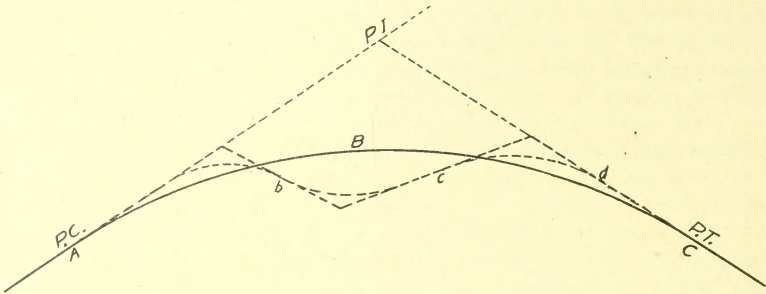


FIGURE 2.

In making a survey for the relocation of an old road, the following method is very satisfactory. It consists in making a survey of the old road and noting where and to what extent changes are desirable and feasible. Then a map is made to a scale of 1 inch=50 feet (not smaller than 1 inch=100 feet). The new road is now laid out on the map and distances and angles scaled so that the data are sufficient to lay it out on the ground in the proper place.

A convenient method of keeping notes of the transit survey is called the "deflection method" and is illustrated below. The instrument is supposed to be set up at every change in direction.

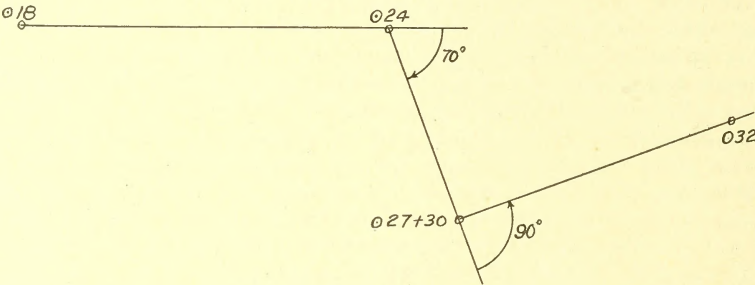


FIGURE 3.

TABLE 1.

Station	Deflection		Bearing	Remarks
	Left	Right		
18				
24		70° 00'	S 20° 00' E	
32	90° 00'		N 70° 00' E	

In places where there are a great many short turns, much time would be consumed in setting up the instrument at every change in direction. Instead of this, several readings may be taken from one position, the distances being

measured around the traverse just as though the instrument were set up at every change in direction.

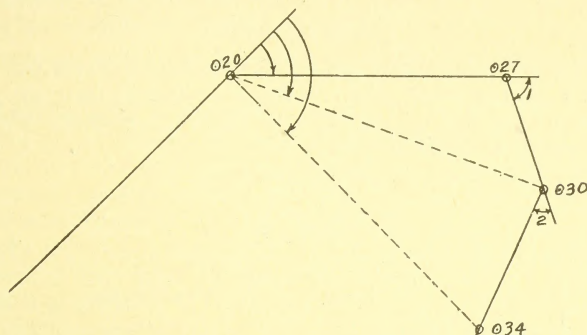


FIGURE 4.

The disadvantage of this method is that the angles 1 and 2 (Fig. 4) are not given directly.

While making transit surveys it is important to take notes of property lines, houses, intersecting roads, stream crossings, direction of the channel, feasibility of relocating stream channel, character of the soil, amount of rock, extent of forest or open ground, etc. It would perhaps be better to have two men go over the line *later* and take full notes of the natural features above mentioned.

The transit party should include at least four persons besides the axemen: transitman, front rodman and chainman, back chainman, and stakeman. The front rodman should display good judgment in selecting tangent intersection points.

LEVELING.

Leveling is done for the purpose of obtaining a profile of the ground. It is the most important feature of the road survey, though often there is no need for it until after the final location survey has been made. The usual method of taking notes for elevations is indicated in the following table.

TABLE 2.

Station	B. S. +	H. I.	Rod	F. S. (-)	Elevation
27 (T. P.)	1.72	106.33	-----	-----	104.61
+ 50	-----	-----	3.1	-----	103.2
28	-----	-----	4.6	-----	101.7
T. P.	0.21	101.32	-----	5.22	101.11
29	-----	-----	2.1	-----	99.2
+62	-----	-----	4.2	-----	97.1
T. P.	-----	-----	-----	12.38	88.44
Totals-----	1.93	-----	-----	18.10	-----

Bench marks should be established at intervals of every one-fourth mile. Check levels should always be run.

CROSS SECTIONS.

The cross sections are usually taken after the final location has been made, by means of a level or hand level. These are taken at intervals of every 50 feet, at culvert sites, and at irregular places in the ground. The cross sections are carefully plotted on paper.

Convenient scales in general are as follows:

TABLE 3.

Plan	Profile	Cross Sections
$1''=100'$	$1''=100'$ horizontal.... $1''=10'$ vertical.....	$1''=10'$ horizontal. $1''=5'$ vertical.
$1''=100'$	$1''=100'$ horizontal.... $1''=10'$ vertical.....	$1''=5'$ horizontal. $1''=5'$ vertical.
$1''=50'$	$1''=50'$ horizontal.... $1''=10'$ vertical.....	$1''=4'$ horizontal. $1''=4'$ vertical.

THE FINAL LOCATION.

The road is said to be *located* when its center line is established on the ground in the position which it is intended finally to occupy. Stakes should be set at intervals of every 100 feet on tangents and every 50 feet, or closer,

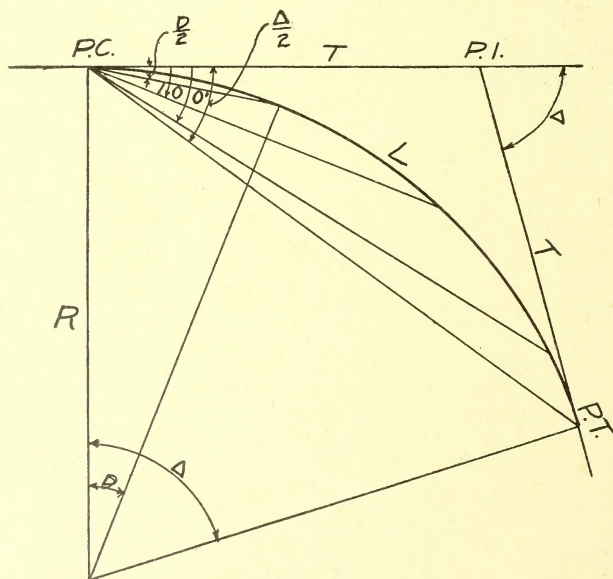


FIGURE 5.

on sharp curves. In cases where the center line is along the traveled way of an old road, nails stuck through red cloth (or better through a tin cap used for holding roofing paper) should be driven at the center points and side stakes set at definite distances from the center.

The curves are usually arcs of circles and are laid out by the deflection method.

Δ = Deflection angle in degrees.

D = Degree of curve = Central angle which intercepts chord of 100 feet.

R = Radius of curve in feet.

T = Length of Tangent in feet.

E = External distance in feet.

L = Length of curve in feet.

P.I. = Point of intersection of tangents.

P.C. = Point of curve.

P.T. = Point of tangent.

$$D = \frac{5730}{R}; \quad L = \frac{\Delta}{D} \times 100.$$

EXAMPLE.

Given

P.I. = Sta. 54 + 71.3.

$\Delta = 19^\circ 00'$, $E = 15'$ (approx.).

From tables $T = \frac{958.9}{D}$; $E = \frac{79.7}{D}$

If $D = 5^\circ 00'$, $E = 15.9'$; hence, $D = 5^\circ 00'$ is OK.

$$\therefore T = 191.8, \quad L = \frac{19}{5} \times 100 = 380'.$$

P.I. = 54 + 71.3

$T = 1 + 91.8$

P.C. = 52 + 79.5

$L = 3 + 80$

P.T. = 56 + 59.5

$$D = 5^\circ, \text{ Deflection} = \frac{5 \times 60}{2 \times 100} = 1.5 \text{ minutes per foot.}$$

Deflection	Station
$0^\circ 31'$	53
$3^\circ 01'$	54
$5^\circ 31'$	55
$8^\circ 01'$	56
$9^\circ 30'$	56 + 59.5

$$9^\circ 30' = \frac{\Delta}{2} \text{ check.}$$

Figure 6 (p. 24) shows a parabolic curve which is laid out as follows: find the middle point of ad at m , then the point half way between m and b ; this gives C the center of the curve. Other points on the curve are found by measuring offsets from the tangents, as is indicated. Note that the offsets from the tangents vary as the *square* of the distance.

GRADE LINE.

The fixing of the grade line upon the profile is one of the most important operations in the design. The most economical grade line is usually that

which most nearly balances the cuts and fills. A convenient method of laying a grade line that will approximate these conditions is as follows: Place a templet (with the shape of the finished road) on each cross-section so that the cuts will just balance the fills (this position is estimated) and note the

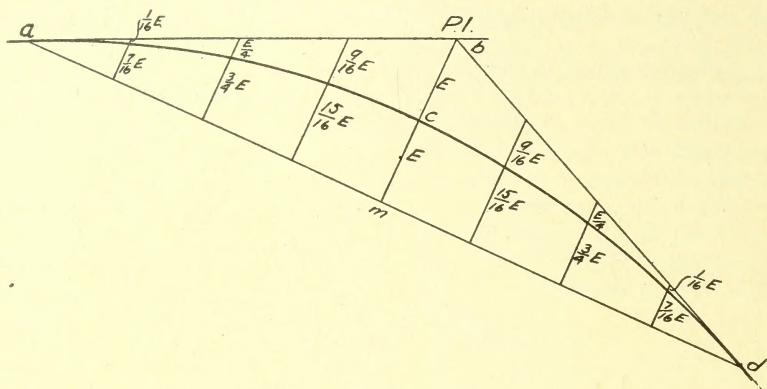


FIGURE 6.

elevation of the center line of the proposed finished road for this position of the templet; mark this elevation on the profile for each section, between certain stations. To connect these points would give the most economical grade line, but this can rarely be done so as to get a smooth grade. The adopted grade is obtained by drawing in a smooth grade line that averages the elevations of these points, as is shown in Fig. 7.

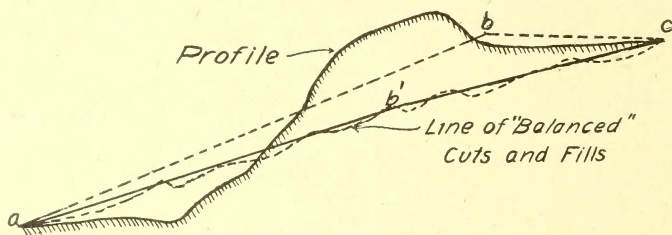


FIGURE 7.

Line *abc* appears to balance cuts and fills, but actually grade line *ab'c* is near the line of "balanced" cuts and fills on account of irregular cross sections.

CROSS SECTIONS.

As soon as the grade line is drawn on the profile, the center cuts and fills are either scaled or computed. The latter method is more accurate and is done as follows (see Table 4):

TABLE 4.

Station	Elevation— Ground	Elevation— Grade	Centre	
			Cut	Fill
12	106.2	106.2	0.0	-----
13	112.2	110.2	2.0	-----
14	113.2	114.2	-----	1.0

The shape of the finished road is now drawn on the cross sections at the proper depth above or below center and the areas in cut and fill are determined either by counting squares or using a planimeter.

The volume of earthwork is computed by means of the "average end areas" formula, which is:

$$V \text{ (cubic yds.)} = \frac{A_1 + A_2}{2} \times \frac{L}{27}$$

$$\text{If } L=50', \quad V = (A_1 + A_2) \times \frac{25}{27}$$

where A_1 and A_2 are end areas in square feet, and L =length of section in feet.

The following table shows a good way to record the volume quantities:

TABLE 5.

Station	Centre		Area		Double Area		Distance—Feet	Volume—(Cu. Yds.)	
	Cut	Fill	Cut	Fill	Cut	Fill		Cut	Fill
12	0.0	-----	20.0	16.0	-----	-----	-----	-----	-----
	-----	-----	-----	-----	220	16	50	204.0	15.0
+50	2.0	-----	200.0	-----	-----	-----	-----	-----	-----
	-----	-----	-----	-----	364	30	50	337.0	28.0
13	1.0	-----	164.0	30.0	-----	-----	-----	-----	-----
	-----	-----	-----	-----	164	247	100	304.0	458.0
14	-----	1.4	-----	217.0	-----	-----	-----	-----	-----

SETTING SLOPE STAKES.

With depth of cut or fill marked on the center stakes, and slope stakes set with the distance out and the elevation above or below center marked on them, and a profile, showing direction of haul, the survey is completed and ready for construction.

In conclusion, an example will be given showing the order of procedure from the beginning to the end in surveying and mapping and estimating the cost of constructing a difficult section of road in Orange County. The various steps were as follows:

- (1) Reconnaissance.
- (2) Preliminary survey with transit.
- (3) Level survey.
- (4) Cross sections.
- (5) Map showing plan profile and cross sections.
- (6) Paper location of road.

- (7) Projected profile obtained from elevations of the off-set points as given by the cross sections, where changes were made.
- (8) Trial grade line and rough estimate of cost.
- (9) Decision as to length of span and width of bridge.
- (10) Center line tangents and curves laid out on the ground.
- (11) Level readings at every stake.
- (12) Cross sections every 50 feet and oftener.
- (13) New profile drawn.
- (14) Cross sections plotted.
- (15) Grade line drawn on profile.
- (16) Shape of road placed on cross sections and areas computed.
- (17) Volumes computed.
- (18) Slope stakes set.
- (19) Bridge abutments and wing walls staked out, and volume of concrete computed.
- (20) Detailed drawings of abutments for contractor.
- (21) Specifications for bridge.
- (22) Position of culvert located, with proper size, length and slope.
- (23) Borrow pit staked out.
- (24) Provision for traffic during process of construction.

Use of the Abney Hand Level.

BY T. F. HICKERSON, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF NORTH CAROLINA.

The Abney hand level is a more useful instrument in road engineering than the ordinary Locke level because with it both a level and incline line

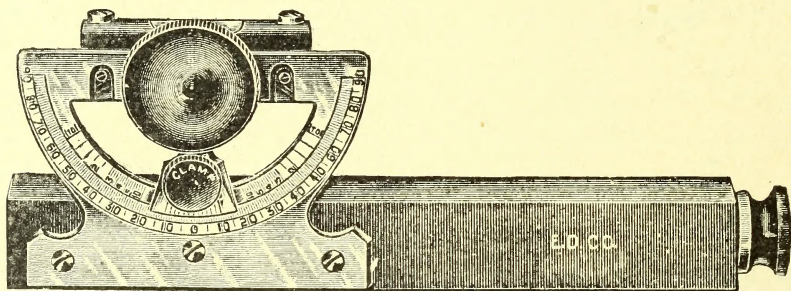


FIGURE 8—Abney Hand Level.

of sight may be established. Its usual form, Fig. 8, consists of a square bronzed sighting tube 5 inches long, a vertical arc having a radius of 1 inch graduated to single degrees with a folding vernier reading to 5 minutes, a scale of grades from 1:1 to 1:10, and a bubble. The price, including a leather pocket case, is about \$13.50.

METHOD OF USE.

Since grades are usually expressed as a per cent, that is, the rise or fall per 100 feet of distance, it is necessary to know the relation between degrees and per cent slopes, which should be remembered as being in the ratio of 4 to 7.

Thus a 7 per cent grade is equivalent to a $7 \times \frac{4}{7} = 4$ degree grade. The fol-

lowing table gives the degrees and minutes corresponding to per cent grades varying from $\frac{1}{2}$ per cent to 10 per cent.

Per cent slope.	Degree slope.	
	Deg.	Min.
$\frac{1}{2}$	0	17
$\frac{3}{4}$	0	26
1	0	34
$1\frac{1}{2}$	0	52
2	1	09
$2\frac{1}{2}$	1	26
3	1	43
$3\frac{1}{2}$	2	00
4	2	17
$4\frac{1}{2}$	2	35
5	2	52
6	3	26
7	4	00
8	4	34
9	5	09
10	5	43

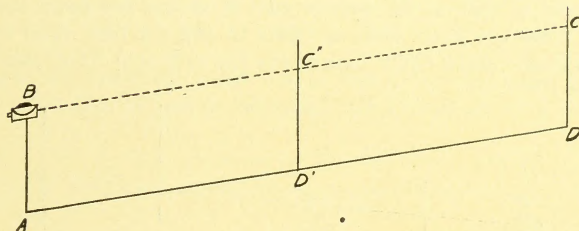


FIGURE 9.

To Locate Points on Grade.—Suppose A, Fig. 9, is a known point on grade and it is required to locate a point D, so that the slope A D shall be on a given per cent grade parallel to the line of sight B C. Set the vernier to read the angle corresponding to the per cent grade and with the instrument held at B in position for sighting, in the hand or on a jacob staff, then place a rod alongside A B with the bottom on a level with the point A and place a target opposite B on the rod at the "height of instrument" above A. When the "Abney" is swung slightly upwards or downwards until the bubble is in center (this position being shown by means of a prism which throws a picture of the bubble into the field of view), the line of sight B C will be parallel to the desired grade and it is only necessary to have the rod moved about until this line of sight strikes the target in order to locate points at the bottom of the rod so that they will be on grade. Thus, if the target points C and C' are in the line of sight, the points D and D' are on the required grade. It should be noticed that this method of establishing grade points is independent of distance.

To Determine the Amount of an Existing Grade.—Choose two points on the grade. With the instrument held above the first point in position for sighting, place a target on the rod at the "height of instrument," and with the rod held on the second point, move the vernier up or down until the bubble remains in the center and the line of sight strikes the target; then

clamp the scale and read the angle. This gives the grade expressed in degrees which, if multiplied by $7\frac{1}{4}$, gives the per cent grade.

There is another way to find the amount of a slope, as in the case of a steep bank. Place the base of the level tube parallel to the surface, move the vernier until the bubble comes in the center, and read the inner scale which gives the slope directly as 1 to 1, 2 to 1, etc.

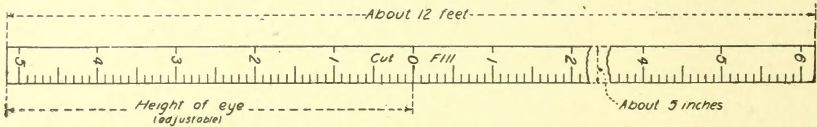


FIGURE 10.

To Determine Cuts or Fills.—A convenient rod for use in connection with the hand level, Fig. 10, is graduated as follows: Mark the height of eye (same as "height of instrument") and label it zero (this would be the approximate height of eye if the rod is made adjustable at the bottom so as to be adaptable for persons of different heights), then lay off distances measured in feet and tenths downwards from the point zero to perhaps five feet or more, depending upon the height of eyes of the person who is to use the hand level, also lay off similarly from the point zero upwards to say six feet, thus giving a rod about 12 feet long. Mark "Fill" just above the zero and "Cut" just below it.

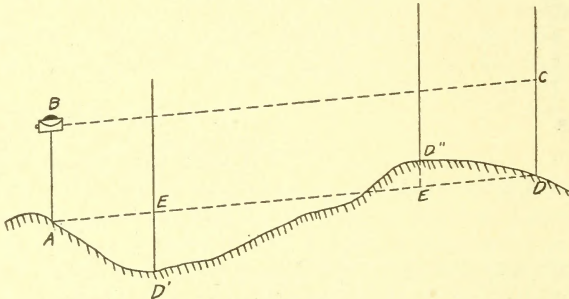


FIGURE 11.

Assume A and D, Fig. 11, to be two points on grade and the instrument set to give a line of sight B C parallel to the grade A D. If the rod is held at D' then the rod reading will be the fill D' E; also if the rod is held at D'' the rod reading will be the cut D'' E.

To Determine Cross Sections.—Suppose A, Fig. 12, is a point on the ground at the center of the proposed road, and it is desired to find the cross profile of the ground on both sides of the point A. With the instrument set to read zero and the zero of the rod at the "height of instrument" (above A) sight on the rod held at all the breaks in the slope of the ground at measured distances from A and the rod readings will give the elevations of the various points above or below A. If the line of sight should run in the ground or be above the top of the rod, move up to the last point or some convenient point and proceed as before, remembering to add to or subtract from the reading for the second position all subsequent readings, in order to refer all elevations to the first position.

A convenient way to keep notes is to express the data in the form of a fraction, the numerator representing the elevation above or below A and the

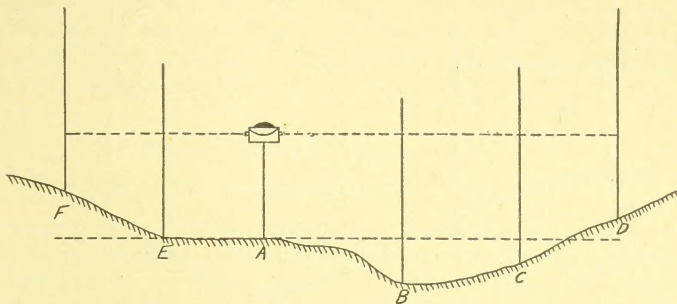


FIGURE 12.

denominator the distance from A. Thus the following notes represent the conditions shown in Fig. 12:

<i>Left.</i>		<i>Right.</i>		
+1.7	0.0	−2.1	−1.0	+1.8
—	—	—	—	—
20	9.0	12	22	30

According to the notes, the point B is 12 feet to the right and 2.1 feet below A; also, the point D is 30 feet to the right and 1.8 feet above A.

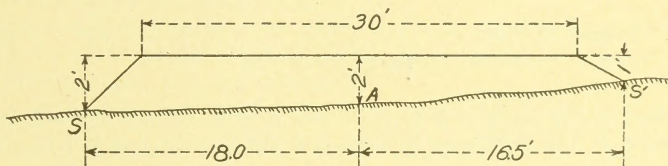


FIGURE 13.

To Set Slope Stakes.—Suppose the center fill at A, Fig. 13, is 2 feet and the road is to be 30 feet wide with banks sloping $1\frac{1}{2}$ horizontally to 1 vertically. It is required to find where the slope of the banks intersects the surface of the ground.

Set the vernier to read zero and clamp it. Use the rod shown in Figure 10. With the instrument at the height of eye above A, sight on the rod held at a distance of at least 15 feet. The rod readings give the elevations above or below A. The method is to guess at the distance and try the elevation, or vice versa. The point S is correct because the rod reading is 0.0 and the distance is $15 + 2 \times \frac{3}{2} = 18.0$ feet. The stake S shows where the fill begins and

it should be labeled thus

{	FILL
	2.0 indicating that it is two feet below and 18.0
	18.0

feet from the center of the finished road. The stake at S' should be labeled

{	FILL
	1.0
	16.5

Differential Leveling.—The “Abney” when set to read zero can be used just as an ordinary level to determine the difference in elevation of two or more

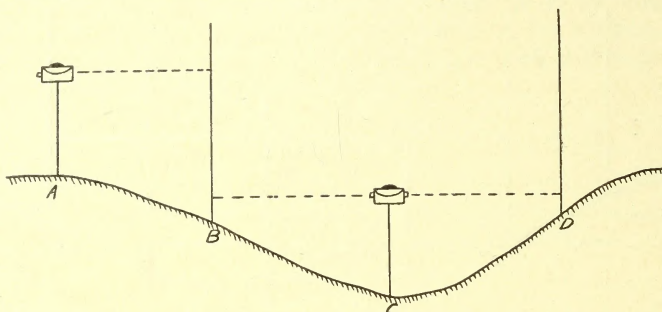


FIGURE 14.

points, in cases where great accuracy is not required. If a rod graduated up and down from the height of eye is used, the notes may be kept as shown in the table.

Station.	+	—
A	...	...
B	...	5.0
C	...	4.2
D	4.0	...
Total	4.0	9.2
Difference = — 5.2		

According to the notes, B is 5 feet below A, C is 4.2 feet below B, and D is 4 feet above C, the difference in elevation between A and D being 5.2; the difference between the sum of the plus and minus readings.

Adjustment.—Set the scale to read zero and raise or lower one end until the bubble remains in the center, then reverse the position of the instrument end for end and if the bubble is out of center the level is not in adjustment. To adjust it, turn the capstan headed screw at the end of the level tube until the bubble comes half way to the center. In order to adjust exactly, several trials are often necessary.

A good way to test the adjustment is to stand on some point A and sight on a target held at the “height of instrument” above another point B and note the angle. Then stand at B and sight on the target held above A and see if the angle is the same (on the other side of zero).

ADAPTABILITY OF THE ABNEY LEVEL TO HIGHWAY LOCATION.

The writer has found the Abney level indispensable in side hill location. It enables one to determine grade points quickly and is a time saver in running preliminary trial lines. As to its accuracy, the readings taken not over 100 feet apart (preferably about every 50 feet) should be within $\frac{1}{2}$ inch of exactness, provided, of course, the instrument is in adjustment and the engineer is careful to keep the “height of instrument” constant. The errors are compensating and for this reason the Abney, in the majority of cases,

will give a preliminary line close enough to be adopted as the final location. The writer has used this level in laying out fully 75 miles of road in hilly and mountainous country.

Very few highway engineers seem to be familiar with the merits of the Abney as compared with the Locke level. It has all the advantages of the Locke and many additional uses.

Economics of Road Construction.

BY W. S. FALLIS, OF HENDERSON, N. C.

The economics of road construction is a subject that is a part of every phase of the road question. Every advantage claimed for the betterment of our roads has its economic side. There is no movement today that commends itself more fully to the support of all the people than the construction of good roads. There is little danger that too much money will ever be spent for this purpose, if there is proper and intelligent consideration given to the financial and construction problems which it involves.

It is not necessary for me to discuss the question of the advantage of good roads throughout the counties of our State. I will, therefore, confine myself to discussion of the proper expenditure of the funds to be used in the construction of roads.

Public roads are built for the use of the people free of cost in the same manner as the public school, the museum or the park; but, though free in a direct way to the user, they are not free in the economic sense because they have involved expense and effort to some one.

What things shall be provided for public use is a question of great public interest, and one of the most difficult problems concerning taxation to be solved by the legislator and the economist.

Economic goods is a term used to describe those things which men want that are not free, but which present the problems of individual or organized industry.

All the constructive efforts of man are of a temporary nature. No sooner has he completed some construction than both nature and man begin to destroy it. The word permanent in its full sense cannot be properly applied to anything made by man.

This is true of roads, and especially true of the road crust or surface. Rain, frost and traffic are the three greatest agencies tending to destroy it. If the road is to retain its value as a road, if the capital invested therein is to remain unimpaired, a sufficient sum of money must be expended yearly to repair the deterioration caused by nature and by the wear of traffic. If this money is not provided and properly expended, the original investment will in time disappear through depreciation.

As Dr. Pratt so earnestly insists, good roads should be good for three hundred and sixty-five days in the year. This, of course, does not mean that the roads shall be so expensively constructed as to present an unvarying surface, a surface as perfect during the worst weather, and under the most adverse conditions as during the period of the year when all roads are at their best; but it means that the construction shall be such that, within reasonable limits, the efficiency of the road shall be maintained throughout the year, due consideration being given to the cost and class of the surfacing. This can be made practicable only where the roads are skillfully and pru-

dently planned, honestly built, carefully financed, and thoroughly and continuously maintained.

It is not my purpose to go fully into that phase of road economy which would involve a discussion of the subject of raising funds for the work; but I must voice an earnest warning in regard to the expenditure of a certain class of road funds.

It is a common thing for our counties and cities to issue bonds, for extended terms, for the purpose of road and street improvement. In many cases this is a proper way for them to procure funds for much needed improvements; but it is all too common an occurrence for the money thus raised to be spent in work of a temporary nature. In many cases, where the money is borrowed for, say thirty or forty years, the purpose for which the bulk of it has been spent has entirely disappeared in perhaps ten years. If recklessness of this nature is persisted in (and no one can deny that it is now very common), a reaction, more or less serious, in the progress of road building is sure to result. The remedy for this is not to prohibit the issue of bonds for either long or short periods of time, where other funds of sufficient amount are not available; but to intelligently and prudently plan the expenditure of such funds, so that a large measure of value may remain in the work at the expiration of the time for which the bonds were issued.

The road surface, in many of its more or less expensive forms, is of such temporary nature that it is extremely wasteful, to say the least, for counties whose present wealth is such that funds for road improvement are limited, when compared with the amount of mileage and the topographic and other natural difficulties, to expend large sums on surfacing their roads or in ill-considered endeavors to secure a large mileage of poorly constructed roads.

When money for the initial work of road improvement in a county is to be expended, no matter how the money has been procured, prudence demands that a careful investigation by competent, trained and experienced men shall be made and definite plans determined upon before any work is begun. This is especially true when money raised from long term bonds is to be used.

A definite plan is needed in order, among other reasons, to distribute as equally as possible the benefits of the improvement to the tax payers; to eliminate as far as practicable changes in value to the individual property owner, by following as nearly as may be the general course of existing roads; to determine the kind of surfacing, its probable cost, and the probable cost of maintenance; to consider in every phase the future of the system of roads; and to spend the bulk of the money in the more permanent parts of the road. The location, the grade and the drainage of a road are the more permanent parts and the only parts that can reasonably be expected to contain any part of the original investment at the time the bonds of a thirty or forty year issue are due.

I, therefore, earnestly urge that the larger part of the funds now being spent on the roads throughout the state be used for laying a foundation upon which, in the future, improved surfaces can be built.

SOME FACTORS IN THE ACTUAL WORK OF CONSTRUCTION.

Economy in the actual construction of roads can be assured only when the laws are such as to guarantee to the local or county administration sufficient power to handle to the best advantage the various problems they will have to meet.

The executive body or county board itself should be free from politics and political connections or ambitions, men of unselfish motives and high purposes. This condition in every aspect is, perhaps, unusual but not impossible of attainment, as my own experience has demonstrated.

An engineer should be employed who is competent and experienced and who has a high conception of his profession. Ample power should be given him to decide and enforce all questions that are entirely professional in their nature, and his advice should receive full consideration by the commission where the matter is both professional and administrative. To illustrate: It should be the function of the Road Commission to plan the order in which the roads should be built; and to name the two or more points between which a road is to be built. It is the right of the engineer to determine all matters relating to the location of the road between these points. He is held responsible for this by the profession generally; by the people of the county especially; by the Road Commission directly; and, therefore, this is his right as a matter of simple justice. Should the question be one of the class or quality of construction to be used at a given place, or in the general work, the office of the engineer should be advisory in nature just as a lawyer advises his client.

The question of obtaining right-of-way for road purposes is vital to all the tax payers, and is an avenue through which a considerable percentage of the county road funds may disappear. This accentuates the necessity of broad justice in handling it rather than a too close observance of the written law.

Experience has taught us that a good road increases the value of land, according to the distance from and the accessibility to it. The value of the land abutting on the road is, of course, increased much more than that of land lying farther away. It is seldom possible to injure a farm by building a good road through it, and the place where actual damage can be done is very exceptional.

Every tax payer in the county shares, according to his property, the burden of road improvement. He should, therefore, receive his due measure of benefit from the money expended thereon.

In estimating from my experience this item, the cost of right of way for road construction, will, if neglected or allowed to be handled according to the average county law, amount to something like two hundred dollars per mile of road wherever relocation, or even partial relocation, is required. This money was originally appropriated by the people for the purpose of building roads, and every man paying a road tax has the right to know that his money has been used in building roads. Every dollar spent to pay "A" for right of way gives "A" a dollar and a good road that enhances the value of his farm more than that of the farm of his neighbor which does not touch the road, while it takes from "B," who may be unfortunate enough to live just beyond, a dollar and a good road. The dollar paid to "A" should in all justice go into a road for "B." My experience has proven conclusively that an equitable method of adjustment can be arranged that will not bring undue friction to the Road Commission nor work harm to any one.

Experience and care are necessary in organizing for work if economy in the work is to be assured. Every effort should be made to keep the overhead or administrative expense as low as possible. When little time and nominal responsibility is required of a board member, the expense for his service

should be nominal. Members of the County Road Commission, if paid at all, should be paid for the actual time given to the work. I would suggest that the amount should not be designated until the organization has been completed and work well begun, for the reason that the bulk of the work required of or necessary to be done by members of the commission is several times larger at the commencement of the work than later on. If designated during the time of organization, it will frequently result in larger allowances for the service of executive members than they themselves would consider equitable and just at a later time.

The superintendent and foreman should be men of experience in the class of work they are expected to do, well qualified in every way for handling the machinery, equipment and work. Many mistakes are being made in the selection of these men. They constitute the most important part in the organization, so far as economy in getting results is concerned. Great care and experienced judgment should be used in selecting just the right men.

A good foreman for this class of work should have the qualifications usually needed by men placed in authority over labor. He should be sober, industrious, sufficiently educated, and a man of good judgment in handling labor; but he should be especially experienced in handling earth excavation by the use of the kind of machinery provided; should know when he is getting results; and should understand thoroughly the proper amount of work to be done by his mules. This last and special experience is vital, for on it depends, more than on any other one thing, the cost of the work.

In an organization requiring a superintendent, and when several outfits are worked, the service of a superintendent as a general executive is absolutely essential for the systematic and, therefore, economical conduct of the work. His duties are so obvious and at the same time so numerous that I shall not go into details, but simply say that his chief duty is to keep the various outfits in condition to work at their highest efficiency.

It is my opinion, based on my own experience in this class of work, that for the construction of sand-clay or topsoil roads, or for any class of road work where the bulk of the expense will be in the excavation and grading, the most economical method is by county organization in preference to contract work. This is not the result of any prejudice or hasty judgment in the matter, but the result of careful investigation. I have been, in common with the majority of engineers, inclined to favor the contract method in many classes of work. The plan of contracting is without a doubt the cheapest in many classes of construction work. In cases where the amount of work in grading is so small that the cost of organization and proper outfit would be excessive in comparison, or where the class or kind of work calls for an expensive outfit that will be useless capital in the hands of the county when the work is completed, I would unquestionably favor contract work.

In support of the idea favoring county organization I would state that the outfit required for road construction when sand-clay or topsoil work is to be done, with the exception of the mules required, may, after about two years' work, be considered as very nearly or quite worn out when the work is completed, and its value almost entirely incorporated in the work. The depreciation in the value of the mules can, very conservatively, be estimated at ten per cent per annum. To demonstrate this I will refer to the work in Franklin Township, Franklin County. The depreciation in the value of the mules,

after nearly four years of service, amounted to nine per cent per annum. The cost of each team per day was 20.6 cents of the capital invested therein. The cost per cubic yard of the work, after a careful calculation which included the total cost of all tools and machinery in the expense involved, was not quite fifteen cents. The depreciation of the mules used in Franklinton Township was perhaps greater than would ordinarily be the case, as they were used for a longer period than mules should be used. The most economical method of handling this item is to purchase young mules five or six years old and of not less than eleven hundred pounds weight, work them for two or two and one-half years, and sell them before their annual depreciation becomes great on account of their age.

To refer again to the importance of the qualifications of foremen, I wish to quote some figures that came within my experience.

In one of the counties in which I had charge of the work, I used six outfits of equal equipment and on like work. Two of the foremen were men experienced in the class of work they were doing. The other four, while energetic, hard working men, had never handled that kind of work. At the end of three months I made an investigation of the results (this investigation should have been made at the close of the first month, but the cost accounting was in such shape that I could not get at it) and found that the two experienced men were handling their work close to sixteen cents per cubic yard, while the other four were averaging around twenty-eight cents. In other words, considering the total yardage handled by the different outfits, the two experienced men had in each case given in value about \$1,300 more in work, although I was at that time paying all six of these men the same salary.

I cannot close this discussion without saying something in regard to the keeping of cost accounts, and their importance in holding down the cost of work.

If, in the above reference to the comparative value of the foremen, I had been able to get at the *results* of my endeavor to keep track of the costs, I would have saved some hundreds of dollars in that first three months; and this, while very important, is only one of the leaks in construction work that a proper cost accounting will expose.

The method that is considered sufficient as a rule, simply seeing that the men have worked the number of hours for which they are paid and that the goods were received for which the bills are paid, is an utterly insufficient and worthless handling of a valuable auxiliary for the economical conduct of the work.

I would add, in closing, that a constant watchfulness over and understanding of all the elements that go into road construction must be constantly maintained by the responsible head of the organization, if the best and most economical results are to be obtained.

Sandelay and Topsoil Roads the Economic Roads for North Carolina.

BY JOSEPH HYDE PRATT.

In many sections of North Carolina the communities have not sufficient funds for road purposes to enable them to construct the more expensive roads such as, bituminous macadam, bitulithic, vitrified brick, concrete, or even water-bound macadam. There are roads, however, that come within the

means of all communities, and these are the sand-clay and topsoil. Unless traffic is very severe these roads will give satisfactory service, and, whenever the traffic becomes so heavy that a harder surface is necessary, there will be a splendid foundation upon which to build the new surface road. It will also mean that the community has acquired sufficient wealth to enable it to build harder surfaced roads. Where counties have sufficient funds to enable them to build macadam roads the North Carolina Geological and Economic Survey advises that such counties build the bituminous macadam roads in the environment of their cities. Where the traffic is less heavy, supplement this road with the sand-clay or topsoil road leading to the boundaries of the county.

In discussing a sand-clay, topsoil or gravel road we must bear in mind that we have under consideration a specially surfaced road, just as distinct a road as the macadam, cement or vitrified brick. The same care and preparations should be employed in grading and preparing the roadbed for these surfacing materials as when the other, harder materials are to be used. The present paper deals with the surfacing of the road after the grade has been completed. The portion of the road that is to be surfaced with sand-clay, topsoil or gravel should be left nearly flat and sufficiently lower than the shoulders so that when the surfacing is completed, the road will have the right slope from the center to the ditches.

There is a tendency in grading the roadbed to leave that portion which is to be surfaced too high, with the result that either the finished road has altogether too steep a crown or the surfacing material is not thick enough. The thickness required will depend upon the character of the subsoil.

In certain localities where there are both clay and sand soils, the ordinary country road is found to contain sections that are composed principally of clay, others of sand, and occasionally a section is observed that is hard all the time. This, upon investigation, will be found to be composed not of clay or sand but a mixture of these two. In such regions it is not uncommon to find soils that are a mixture of sand and clay and in such proportions that when used for surfacing a road they make a hard surface like the natural surface just referred to. Such material is known as topsoil, and the road as a "topsoil road." When, however, it is necessary to mix the two artificially it is called a sand-clay road.

I first want to take up the sand-clay road: A recent article in the *Greensboro Daily News* gives the following:

"Of the various stretches of sand-clay about Greensboro, some are now in good condition, some are very bad and some are neither the one nor the other. All have gone through the same weather, and the differing conditions are in evidence on stretches of road that have apparently had about the same amount and kind of traffic. Why is it that some parts are still good and others are horrid? Answer that, and you have found all the essential secrets of substantial road building and maintenance in this part of Guilford County."

This is undoubtedly true and it will still be found that one section of the road was constructed in the right way and with the right kind of materials.

CONSTRUCTION OF THE SAND-CLAY ROAD.

Quality of the Sand and the Clay.

Before beginning the construction of a sand-clay road, the sand and clay in the vicinity of the road should be examined to ascertain whether they have the right properties necessary to build a first-class sand-clay road. The best sand or gravel to use is that which has a sharp cutting edge and it should not be in too fine grains. A clean, sharp grit, such as is desired in making mortar is the quality of sand that is wanted. The best results are obtained, however, when the grains of sand are coarser than those used in making mortar. While any clean sand will make a sand-clay road, the sharper the grit the better the resulting road. The characteristics which are most desirable in the clay are plasticity and the ability to slake well when it first becomes wet. A clay is called plastic when it becomes sticky or dough-like when mixed with a certain amount of water, so that it can be molded or pressed into various shapes which it will retain even after it has been dried. If a lump of such clay is put in water, it will usually retain its form for a long time. There are other clays, however, which will immediately fall to pieces when placed in water as a lump of quick-lime will do under similar conditions. This is due to the very rapid absorption of water into the porous construction of the clay. It can readily be seen that this characteristic is an important one when considering the material to be used in a sand-clay road. There is still another physical characteristic of clay which is to be considered from the standpoint of the road builder. Some clays shrink when dried, which is shown by the cracking and breaking out of their surfaces. This shrinkage is the measure of their expansion and expansion makes a sand-clay composition unstable. Shrinkage would do no harm if the clay would stay in this condition, but it does not. When water, removed by evaporation, is restored to the sand-clay mixture, its entrance is accompanied by a simultaneous expansion which causes the grains of sand to become separated. This property can not be overcome, for it is inherent in the clay; but we can, in some measure, modify this fact by using less clay in the composition. This, however, will weaken the road and cause it to break up in dry weather. Avoid such clays if possible.

One good test for a clay is to wet the thumb and place it against the clay, and if it sticks to the thumb it is of the right quality for making a sand-clay road. If, on the other hand, it does not stick to the thumb, we are safe in assuming that this particular clay will not make a good binder. In general, select the stickiest clay and the sharpest sand available.

The proportion of sand and clay in the best sand-clay road should be such that there is just a sufficient amount of clay, and no more, to fill the voids between the grains of sand when these grains are touching each other. The clay is the binder that is to hold the grains of sand in place and there should not be any more than is sufficient for this purpose. If too large a proportion of clay is used, the grains of sand are prevented from touching each other and are able to move about each other in the mass of clay so that the resistance of the mass to the wearing effect of traffic is practically no more than if the road was composed simply of clay. Water is also able to act upon the mass of clay and the road becomes sticky and muddy. If there is too small a proportion of clay used, the grains of sand are not cemented tightly together and the road disintegrates very quickly under traffic and rain.

The exact proportions of sand and clay for making the best sand-clay road can not be stated, as the proportions vary with the character of the sand, according to its sharpness, percentage of foreign material and size of grains. Approximately there is in a sand-clay road about eighty per cent sand and twenty per cent clay. One simple means of determining the theoretical amount of pure clay that should be added to any sand that is to be used in the construction of a sand-clay road is to fill a glass tumbler brimfull with the sand that is to be used and then fill a similar tumbler with water; pour the water carefully onto the sand until the water comes flush with the surface, which will mean that all the voids between the grains of sand are now filled with water. The amount of water that has been poured into the tumbler containing the sand will represent the proportion by volume of clay that it is necessary to add to that particular sand to fill all the voids with clay.

A suitable clay may be found in the subsoil of the road, to which sand must be added; or the sand required may be the subsoil to which clay must be added; or it may be necessary to obtain away from the road both constituents for the sand-clay surfacing.

Method of Mixing Sand and Clay.

Having determined the source of supply of the best materials for making a sand-clay road, the next question is the mixing of the materials, and this varies with the character of the subsoil, *i. e.*, whether this is a sand upon which clay is to be added or clay upon which sand is to be added, or whether both sand and clay have to be hauled onto the road. It will be found that it is much easier to make a sand-clay road where the subsoil is a clay.

Clay Subsoil.—The road should be properly located and graded. There are two ways of preparing the surface of the road before the surfacing material is added. One which has been found very satisfactory is shaping road from the ditches to within one and a half to two feet of that portion of the road that is to be sand-clayed with the right slope that is desired for the finished road, and then shaping the road from that point to the center with a very slight grade, so that when the surfacing material is added and set it will give the right slope from the center to the ditches. The sand-clay mixture will feather-edge to that portion of the road that has already been given the right slope. Another method is to leave that portion of the road that is to be surfaced about two to three inches lower than what is desired when the road is completed. This will give a shoulder on each side. When this is finished the portion of the road that is to be sand-clayed is within nine to sixteen feet in the center. The portion of the road that is to have the sand-clay surface, either nine or sixteen feet in the center, should when perfectly dry be plowed to a depth of three inches and thoroughly harrowed with a cut-away (disc) harrow. The sand should then be spread over the surface to a depth of four inches and thoroughly harrowed in, and then four more inches of sand spread over the surface, and again thoroughly harrowed. After this mixing of the sand and clay is completed the road should be dragged. A slight crust will form but with the first rain this will break through for the mixed sand and clay underneath have not cemented but are loose particles. After the first heavy rain the road should again be harrowed and then dragged into shape so as to give it the proper crown, and it will

then become a firm, hard-surfaced road. If a roller is convenient this may be used to some advantage.

Very often this second mixing is left entirely to teams. In the end a satisfactory road is obtained, but it takes a much longer time.

If the sand-clay road is constructed as outlined above and good clean sharp sand is used on a plastic clay, a first-class sand-clay road will be the result.

In too many instances in constructing a sand-clay road the sand has simply been spread over the clay and it has been left for teams to mix it in with the clay. This takes a long time and very often there is not a thorough mixing of the two materials, so that the resultant road is not always uniform in its construction and does not give as good satisfaction as when constructed by the method described above.

If the sand is added to the clay road when it is wet, the harrowing can all be done at one time, and, when shaped up and dried out, it becomes a hard-surfaced road. The main objections to making the sand-clay road in this way are that unless the clay road is extremely muddy and wet the harrowing of the sand into the clay causes considerable of the clay to get into round balls, which are not broken up by the harrowing; and that is not as even a mixing of the sand and clay as when they are thoroughly mixed dry and then harrowed later when they are wet.

Sand Subsoil.—If in making the sand-clay road we start with a sand subsoil and have to add clay to this, the method of procedure is somewhat different from the case outlined above. The sandy roadbed should be left flat and then a layer of clay spread over it to a thickness of 3 to 7 inches, according to the quality of the clay and the amount of sand which it contains. If it is a very pure plastic clay, it will take a much smaller amount than if it is a very lean or sandy clay. There should then be spread over the clay a layer of clean sand and the road thoroughly harrowed. After this has been accomplished, the road should be brought back into shape and then after a heavy rain again harrowed and shaped up. There is usually a tendency to get too much clay in making a sand-clay road when the sand is the subsoil. If the clay that has been used is a very plastic clay, there is going to be considerable tendency for it to ball and cake so that a plow can very often be used to advantage in breaking up the lumps. If, however, the mixing is made when everything is perfectly dry, a pretty complete mixture can be obtained by harrowing unless the clay has been dug when it was wet.

One noticeable difference in making a sand-clay road with a sand subsoil instead of a clay subsoil is that the number of loads of clay that it is necessary to haul is much less than the number of loads of sand.

The cost, however, of obtaining a thorough mixture of clay on sand is much greater than with sand on clay.

As stated above, it is impossible to determine exactly the proportions of sand and clay to use either in making the sand-clay road on a clay subsoil or on a sand subsoil; and, therefore, as the road dries out and sets it should have careful attention after it is completed to determine whether it is necessary to add any more sand or clay. If there is too much clay there will be a tendency for the surface of the road to get sticky or muddy in wet weather and for the clay to ball and cake, and if this is the case a thin layer of sand should be spread over the surface. On the other hand, if the surface of the road loosens in dry weather, it is an indication that the clay that has

been used is not a good quality of clay and does not have sufficient binding power. More clay should be added and worked into the road.

Drainage is one of the most essential features in road construction and it is very true in connection with the construction of the sand-clay road that it shall have good drainage. Where the subsoil is a sandy one it usually affords a pretty good natural drainage; and where there is considerable depth to the sand, usually the crown of the road is all the drainage that has to be done. It is necessary, however, in all cases that the water be taken out of the side ditches just as rapidly as possible. Where the subsoil is a clay, very careful attention must be given to the question of getting rid of the surface water. Also in clearing the right of way for the road, all stumps, logs, and other vegetable matter should be taken out of the roadbed for, if not, after the sand-clay mixture has been made, wherever vegetable matter exists it will as it decomposes, make moisture and loosen and soften the sand-clay construction. Proper drainage is, therefore, very essential in the construction of the sand-clay road, and it should be maintained at all times.

Dirt and Loam Base.—Where the roadbed is composed of dirt and loam, it will be necessary to haul both the sand and clay. The surface should be about the same shape as that where sand is added to a clay base, except a little lower between the shoulders, for practically all the material added will build up the crown of the road, but very little becoming incorporated with the original surface.

Add 4" of sand to the road, then 2½ to 3" of clay, harrow thoroughly, and then add 4" more of sand and harrow thoroughly. Best results will be obtained if the materials are thoroughly dry when mixed, filling, harrowing, and shaping of road the same as when sand is added to clay base.

Quantity of Sand or Clay.

The following figures regarding the quantity of clay necessary to add to a sand subsoil to make the sand-clay road, and the amount of sand necessary to add to a clay subsoil will be of interest.

If the roadbed is nine feet wide on a sandy subsoil and the clay is added to a depth of 4 inches, it would require 570 cubic yards of clay to cover a mile of road. For a sixteen-foot road it would require 1,050 cubic yards of clay. If the clay is a first-class plastic clay free from sand and only three inches of clay were needed, this would require 441 cubic yards for a mile of nine-foot road, and 787 cubic yards for a mile of sixteen-foot road.

If the roadbed has a clay subsoil and sand is added to a total depth of eight inches, it would require 1,173 cubic yards per mile for a nine-foot road, and 2,085 cubic yards for a mile of sixteen-foot road.

The actual cost of the construction of the sand-clay road for any section can readily be determined by knowing the distance the sand or the clay has to be hauled and the cost of labor and teams per day.

SUMMARY.

Clay Base.

1. Have the top of the clay graded smooth and about four or five inches lower than it will be when finished.
2. Plow and harrow the top for the width the sand is to be put on, leaving loose but smooth, with no big lumps.

3. Spread an even layer of sand about four inches deep over the top and plow and harrow.

4. Spread four more inches of sand over the top and harrow and drag thoroughly.

5. Use clean coarse sand, even if it has to be hauled some distance.

6. When possible, harrow just after a rain.

Sand Base.

1. Smooth the sand road, leaving it perfectly flat.

2. Spread the clay the desired width and from three to four inches thick.

3. If the sand base is clean sand, drag it up on the clay for a thickness of four inches and plow, harrow and drag thoroughly, preferably after a rain.

4. If the sand base contains loam, haul clean sand from a pit.

5. Use natural sand-clay mixture in preference to pure clay.

As I stated at the beginning of this paper: Occasionally a natural mixture of sand and clay has been found in the right proportion and of the right quality to make a hard surfaced road. Where such materials have been found in the fields adjoining the highway and have been used in surfacing it, the mixture has been called "topsoil dressing" and the resultant road a "topsoil" road. In reality, however, it is a sand-clay road and we have simply used a mixture of the sand and clay which nature has provided.

In using this natural mixture the surface of the road should be prepared the same as for a road where both sand and clay are added.

This natural mixture of sand and clay should be added to a depth of 8 to 12", according to the character of the subsoil, a sandy subsoil requiring the greater amount. After the material has been spread it should, if possible, be harrowed when wet and then dragged. If a spreader has not been used, or if the material has not been raked, a road machine will quickly cut out the greater part of the unevenness, and the drag will finish it.

Occasionally a condition is found where there is plenty of good clay but no sand. In some such cases it has been noticed that there is considerable white quartz, or sometimes trap rock in the vicinity. I believe then it is a feasible proposition to make our own sand by crushing the quartz or trap rock and construct a sand-clay road. In such a case I would use material that would pass a 3-8" screen and catch on a 1-8" screen.

This will increase the cost of the sand-clay road, and its economical use will depend upon the total cost of the road as compared with other surfacing materials.

Dust Prevention and Binders.

The life of the sand-clay road can be increased by using certain commercial binders.

It is believed that glutrin and certain of the light asphaltic and other oils can be used on the sand-clay roads not only to prevent dust but also to harden the surface and make it more resistant to water.

Maintenance.

While the maintenance of a sand-clay and topsoil road is very easy and can be done at low cost, yet it must be constant and systematic. The road drag of the split-log type is the most efficient machine. This should be used just after a rain, as the road is beginning to dry out. The principle of the drag is not to cut and move much material but to push and smear material

and pat it down in the small depression that may have formed on the surface of the road.

Natural Sandclays in North Carolina Piedmont Belt.

By JOHN E. SMITH, INSTRUCTOR IN GEOLOGY, UNIVERSITY OF NORTH CAROLINA.

To a limited extent natural sand clays, though in many places undiscovered, exist in nearly every county in the Piedmont. Their occurrence is quite general in the areas of granite rocks which embrace the following counties in North Carolina: Mecklenburg, Gaston, Cabarrus, Rowan, eastern and southern parts of Iredell and Lincoln, Davidson, Guilford, Alamance, Caswell, Granville, Vance, Warren, Franklin and Wake.

This material is derived from igneous and metamorphic rocks by disintegration and decomposition. Probably the most common sand-clays result from the breaking down of granite which consists of quartz and orthoclase feldspar with or without smaller quantities of several other minerals. As the granite weathers, the quartz becomes sand and quartz pebbles and the other minerals change to clay. A "decomposed granite" is therefore a typical one of the natural sand-clays of the Piedmont and will be taken in this paper for consideration.

A GENERALIZED SECTION.

	<i>Thickness</i>
1. Soil at surface, red to gray and black (humus).....	1 to 2 ft.
2. Subsoil, fine, somewhat compact, red to yellow clay.....	3 to 10 "
3. Clay, coarse and lumpy, rotted rock with some sand.....	5 to 20 "
4. "Gravel," pebbles of quartz and orthoclase, with sand and clay.	10 to 20 "
5. Fragmental rock, partly decomposed angular fragments up to 2 or 3 inches in diameter.....	5 to 10 "
6. Granite, rock masses, angular and broken, much coarser and less decayed than those in No. 5.....	5 to 10 "
7. Solid granite, "bedrock," "country rock."	

Since clay is predominant near the surface, shown in the generalized section, decreasing somewhat uniformly as the depth increases, and since the relative amount of sand and rock increases gradually with the depth, there is a level somewhere in the pit at which these materials occur in any desired proportion. The right quantitative relation of the two constituents used in building natural sand-clay roads is found in No. 4 of the section above.

The figures of the first column represent thickness in the eastern Piedmont, where the depth of No. 4 is from 10 to 20 feet; those of the second column apply to the western counties where this layer is sometimes forty feet or more below the surface. The "gravel" of No. 4 may be found at the surface on low hills between the branches of streams or along the sides of the valleys near the tops of the hills or slopes. Prospecting in such places as these will generally result favorably if the underlying rock produces a good sand-clay.

Fortunately these are desirable locations for they insure perfect drainage in the pit, ample facility for disposition of the overburden, and are near the upland peneplain on which the principal roads are constructed. Productive locations can generally be found in pasture lands or woodlands and it is therefore unnecessary to open a pit in a field or to remove gravelly soils from cultivated areas.

Volumetric Tests.

In the University of North Carolina the method used by classes in Geology 8A, road materials, in determining the relative proportions of the constituents in natural sand-clays is essentially as follows and some of the results are given below:

1. Measure out about 1,000 cc of the material in a conical graduate. Tap the glass with the hand for a few minutes and record the amount.
2. Grind the measured material as fine as possible with mortar and pestle. (Road traffic will provide more wear than this.)
3. Wash the "gravel" thoroughly in shallow pans and allow it to dry. Keep the water containing the clay, allow it to settle (or flocculate it), decant, measure, and report the reading.
4. Put the dry washed sand in the flaring graduate, tap firmly with the hand, and pour from a measured quantity of water into the vessel, permitting it to run slowly down the glass on one side until the voids are filled. Label the material and record the amount of water used.
5. Compute the percentage of voids, the amount of excess clay, and the additional percentage of stream sand necessary to utilize the excess clay.
6. Tabulate results as follows:

TABLE 6.

Number of Test	Original Volume—cc.	Clay Washed Out—cc.	Sand Remaining—cc.	Water Filling Voids—cc.	Volume of Voids—%	Excess Clay—cc.	Stream Sand Necessary—%
4	1,200	330	800	225	31.9	75	17.3
10	2,100	760	1,220	452	37.0	308	39.6
11	800	263	650	212	32.6	51	17.7
12	1,000	125	805	243	30.2	0	0

These samples were taken from a pit at Chapel Hill; No. 10 from a high elevation in it. No. 12 was dug from the floor at the lowest level in the pit.

STREAM SANDS.

When a stream is cutting valleys in an area like the Piedmont, the sand and clay are washed away and separated by the water, the former usually being deposited in bars along the lower course of the stream. These are known as stream sands and are frequently used in road building. The results of several tests to determine the percentage of voids in stream sands are given below:

TABLE 7.

Number of Test	Volume of Sand— cc.	Water Filling Voids— cc.	Volume of Voids— %
2	1,000	366	36.6
4	1,000	320	32.0
9	1,000	386	38.6
10	750	275	36.6

No. 2 is sand from Bolin's Creek. No. 4 is a true gravel, being that which was retained on a screen having square meshes five-sixteenths of an inch each way. No. 9 is Morgan's Creek sand. No. 10 is from the same locality as No. 9, but was closely compacted in the graduate. All of the estimates were made with moderately dry sand.

PRINCIPLE AND ITS APPLICATION.

"The proportion of sand and clay in the best sand-clay road should be such that there is just a sufficient amount of clay, and no more, to fill the voids between the grains of sand when these grains are touching each other. The clay is the binder that is to hold the grains of sand in place, and there should not be any more than is sufficient for this purpose."

From the results given in the above tables, it is seen that in many instances the amount of clay present in the natural sand-clay is too large. This last column in table No. 1, gives as a percentage the number of loads of stream sand to be mixed on the road with 100 loads of the natural sand-clay. In No. 4, of Table 1, for example, the amount of stream sand (voids, 36 per cent) necessary for use with 75 cc of clay is 208.3 cc., or 17.3 per cent of 1,200.

Test of samples of the material taken from various elevations in the pit should be made to determine the exact level at which the correct percentages of sand and clay occur. Loads removed from each level in the pit higher than this, contain a larger proportion of clay and should be put together on a separate part of the road. The material from each level in the pit should be tested and should have the proper amount of clean sand mixed with it on the road to use as a binder the excess clay it contains.

A careful examination of the washed sand and pebbles shows that nearly one-third of it is feldspar (orthoclase) which will, in time, decay, forming clay. This will appear as mud when the road is wet and its occurrence should be the signal to apply additional sand, if a hard surface is to be maintained on the road.

The Department of Geology of the University will make a limited number of tests of sands and natural sand-clays from various parts of the State, if samples are sent by parcel post. They should be accompanied by full information as to source of material, its location and depth in the pit, ownership, etc.

SUMMARY AND CONCLUSIONS.

Natural sand-clays occur in most parts of the Piedmont belt in North Carolina. Careful search on the valley slopes in uncultivated areas will



A.—Dirt road that could be improved 100 per cent by use of split-log drag.



B.—Road with steep grades (average 10 per cent). Travel made more difficult by uneven surface of road; large stones project above road.

usually find locations where pits may be opened. "Gravel" and coarse sand have a smaller percentage of voids than finer sand. When more clay is present than necessary, enough clean sand should be added to use all of it, and a better grade of material can be found at a lower level in the pit.

Dirt Roads.

BY JOSEPH HYDE PRATT.

When we stop to consider the number of miles of road in any county and compare this number with the small number representing the miles of specially surfaced road, we can readily see that it will be a great many years—perhaps, generations—before all, or even half, the public roads are surfaced with macadam or sand-clay. For this reason it is very important that we should give very careful consideration and thought to the construction and maintenance of the dirt road.

When properly constructed, the dirt road can be kept in good condition throughout nearly the whole year, except, perhaps, during periods of severe freezes and thaws. At the present time we have very few earth roads but what can be improved, and usually the question of the improvement is not a very difficult one to solve. (Plate II, A and B.)

The old idea that anybody can build a dirt road is fast losing ground, and our people are beginning to realize that road construction, even of dirt roads, requires the services of men who have been trained in this line of work. As careful thought should be given to the construction of dirt roads as is given to the hard-surfaced roads; and in those counties which rely entirely on the labor tax for the construction of their public roads a great advance can be made if this labor tax is utilized under the supervision of an experienced road engineer.

The location of any public road is the only permanent portion of the road; therefore, great care should be taken that when the road is once constructed there should be no question whatever regarding its relocation. In locating a road it should be done so as to permit of an easy grade—none over $4\frac{1}{3}$ per cent—and should be constructed so that it will readily shed the rainfall. How often we see a road going up a hill and down the other side, when, by building around the side of the hill, it could have been kept at an even grade, reaching the identical point within the same distance, or but little greater.

If, in grading a road, we have any grades over $4\frac{1}{3}$ per cent, it will be necessary to construct across the surface of the road a V-shaped surface ditch to turn the water off the surface of the road, for if this is not done the water will, with the grade over $4\frac{1}{3}$ per cent, have momentum enough to seriously gully the surface of the road. No matter how carefully these V-shaped ditches across the surface of a road are constructed, they are very inconvenient to travel, are hard on the wagons, and should be avoided wherever possible. They can be avoided if the grade is kept below $4\frac{1}{3}$ per cent. In Plate II B is illustrated a steep grade on a road in Davidson County, N. C., which could readily be eliminated by relocation of the road. The surface of the road is uneven, and large rocks are projecting above the surface. "Thank-you-mams" have been made across the road to turn the water off the surface of the road, which add a great deal to the discomfort of travel over this road.

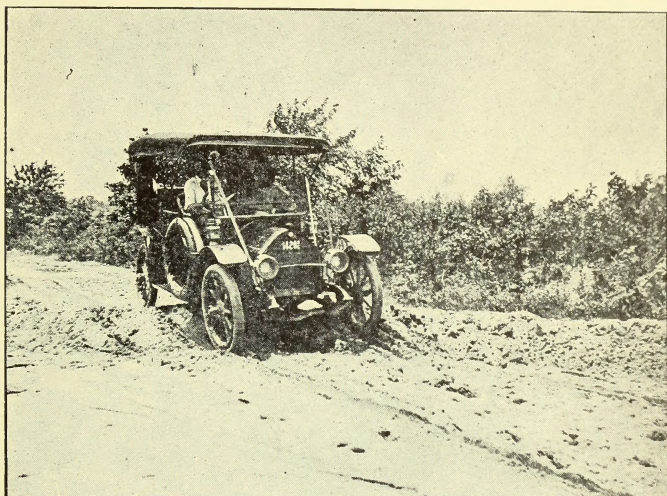
The dirt road is more susceptible to damage by water than, of course, any of the specially surfaced roads; therefore great care should be taken

to work out an efficient system of drainage for the road. Water must be kept away from the road, and the rain which falls on it must be permitted to run off as rapidly as possible, and by a very easy grade. It must not only be taken off the surface of the road as rapidly as possible, but, also, out of the side ditches. Care should be taken that these side ditches are not too steep, and that every opportunity is seized for turning the water out of the ditches into the adjoining fields.

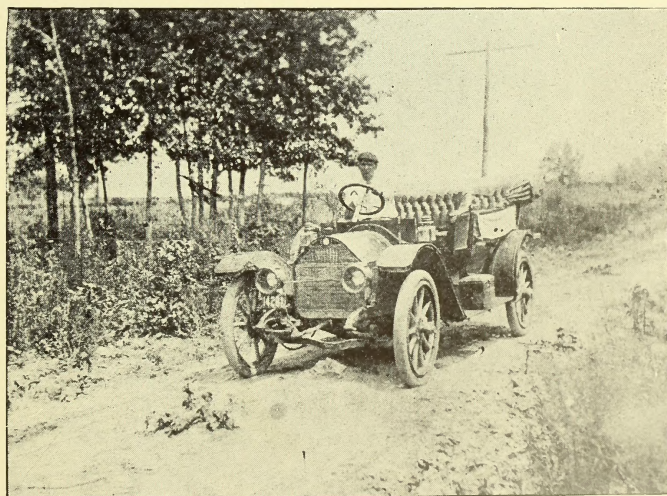
Many of our country roads are bad because in their construction no arrangement was made for taking care of the water, and thus they are very muddy and filled with ruts and holes. Instead of the middle of the road being higher than the edges, so that the water can readily run off on each side, many of them are flat, or even concave, with the center of the road the lowest point. If the road has been constructed so that it is well crowned, with the slope about 1 in 20 from the center of the road to the side ditches, and these ditches have been graded so as to readily take care of the water, and yet not steep enough to cause them to cut deep gullies on the side of the road, and if the water is taken from these ditches at every available point so as to prevent seepage of water under the surface of the road, there should be little difficulty in keeping the road in good condition. Very often it is necessary to carry the water from one side of the road to the other; and when this is necessary, it should be carried under the surface of the road by means of either concrete, metal, or terra-cotta culverts or pipe. The water should never be carried across the surface of the road, for it keeps the surface soft, is apt to flow down the surface of the road unless prevented by high rock, and is a great inconvenience to travel. Plate III, A and B, shows a surface ditch with lower side so high that it would be apt to stall a heavily loaded team. Wooden culverts should be avoided, if possible, and where necessary to use them they should be made of good timber and all planks securely nailed. They should be examined constantly so that they can be kept in good condition. The surface of the road should be kept as near flush with the surface of the culvert as possible.

After the system of drainage has been installed, provision should be made to keep it up, so that the drains and the culverts will not become stopped up.

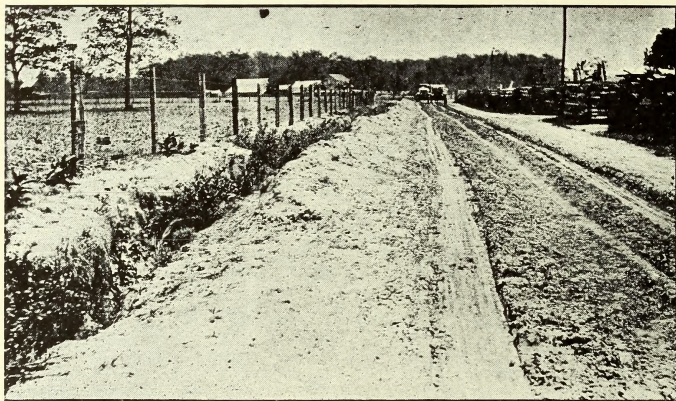
The surface of a dirt road should be kept of dirt, and whenever any holes or ruts have developed in the road they should not be filled up with stone or brush, but with dirt, and with dirt as nearly as possible of the same character as that composing the surface of the balance of the road. If, on the other hand, holes or ruts are filled with rock, gravel, or brush, the wearing effect will be uneven, and the wheels will begin to scoop and cut out holes just beyond or on the opposite side of the road from the hole filled up. If there are stumps or rocks in the road, they should all be removed, so that the dirt surface can be smoothed over and brought to an even slope from the center to the ditches. Plate III B represents a road that it is impossible to maintain properly on account of the stumps. After the road has been well constructed and the right slope and surface obtained, it can be kept in this condition very readily by judicious application of the split-log or King drag. This simple road machine, if used regularly after a rain when the roadbed is wet, will smooth and shape up the road, so that as soon as it has dried out it will be firm and hard. The drag will fill up the ruts and holes



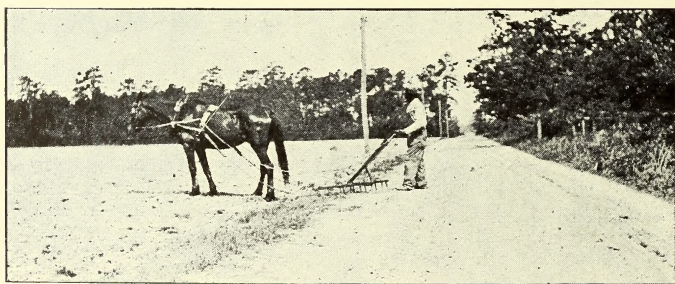
A.—Surface ditch in dirt road for carrying water from one side to another. This ditch should not be used, and the water should be carried under the surface by means of a culvert.



B.—Road where surface contains a great many stumps. Such a road cannot be maintained properly.



A.—Old way of throwing dirt from ditches on side of road, preventing drainage from road into ditch. This scene is in Craven County.



B.—Wayne County farmer using the public road for a turning place for cultivator, thereby damaging the road.

and will keep the dirt road in first-class condition, with hard surface, throughout nearly the whole year. Plate IV A and B.

As moisture is very detrimental to a dirt road, the sun should be permitted to strike the surface of a dirt road as much as possible; and, therefore, care should be taken not to have too much shade along a dirt road, and, where necessary, the trees should be cut away so that the whole surface of the road is exposed to the sun for at least several hours during the day. Shade is good for a macadam road, but too much shade is bad for a dirt road. This does not mean that all trees should be cut from alongside of a dirt road and thus destroy, to a large extent, the beauty of a highway, but it does mean that sufficient trees should be cut so that there will be no part of the road surface but what will be exposed to the sun for a part of the day.

In repairing a dirt road the same thought must be given as in its construction, and, when cleaning out ditches, the material should not be thrown into the middle of the road or on any part of the surface of the road, but it should be thrown into the adjoining fields, for this material is usually composed largely of fine silt and vegetable material, which holds moisture like a sponge and becomes very difficult to dry out, and is entirely different in character and consistency from the dirt surface of the road. How many times we have seen the dirt road repaired by this material being thrown up into the center or just beyond the edge of the ditch, thus preventing the surface water from flowing into the ditches, and often turning it down the road!

In the maintenance of our dirt roads they should be divided into sections, with a foreman or overseer in charge of each section, whose duties should be to go over every mile of his section after every rain and at least every two weeks, and wherever he finds a portion of the road needing repair, he should have it done. After each heavy rain he should run a road drag over the road in order to bring it into shape and to fill up any ruts or holes that might have been started. We must bear in mind that roads will not maintain themselves, and that repairing a road simply once a year will not keep it in good condition.

The cost of maintenance of the public road is often increased by the farmers using the road as a turning place when plowing, harrowing, or cultivating their fields. County and township road commissioners should not permit this, as the farm implements carry a certain amount of soil into the ditches and onto the road. Plate V illustrates this use of the public road which should be prohibited.

In Repairing a Dirt Road.—Don't fill up the holes and ruts in the dirt road with brush, with rocks on top, and a little dirt to cover the rocks; but fill up the hole with dirt of the same character as the balance of the road.

Don't throw all the refuse from the ditches into the middle of the road, thus softening the surface and destroying the solid, firm bed that you have obtained by previous work; but throw this material out on the opposite side of the ditch.

Don't leave the center of the road the lowest point; but make it the highest and give the surface of the road a slope of about 1 in 20 to the side ditch.

Don't carry the water across the surface of the road from one side to the other; but carry it by means of culverts underneath the road.

Don't have grades on your road over $4\frac{1}{2}$ per cent; for if you do it will be

necessary to build V-shaped surface ditches or "Thank-you-mams" across the road.

Don't, in working out the labor tax on the roads, try to make a holiday of it; but give an honest day's work on the road. Let us eliminate what is often seen in those sections where the roads are maintained by the labor tax—ten or twelve men and an overseer, a little gray mule, a small plow, six dogs, three or four guns, and a few tools which often are not considered worth using at home. This road force is not only hard on the rabbits, but also hard on the roads.

Don't reject the split-log drag because it is a cheap road machine, but use it constantly, for it is the most efficient road machine that we can use in maintaining the dirt road.

Drainage of Roads.

By T. F. HICKERSON.

Drainage is a very important matter to be considered in connection with the location, construction, and maintenance of roads, since no road, whether earth or stone, can long remain good without it. Drainage alone will often change a bad earth road to a good one, while the best stone road may be destroyed by the absence of proper drainage. Water is the natural enemy of roads, especially earth roads, for, mixed with dirt, it makes mud. Also, if the water is allowed to flow down the middle of the road, it will wash away the earth and leave gullies. No road, however well made otherwise, can endure if water collects or remains on it or even near it. Prompt and thorough drainage is a vital essential in all road construction, and particularly so for earth roads.

A perfectly drained road will have three systems of drainage, each of which should receive due consideration. This is true whether the trackway is to be macadam, brick, concrete, gravel, sand-clay, or earth, and it is emphatically true of earth. These three systems are underdrainage, side ditches, and surface drainage.

The object of artificial underdrainage is to remove the water from the soil directly underneath the road surface in places where there is no natural underdrainage, because an undrained soil is a poor foundation, while a dry subsoil can support almost any load.

A good method of securing underdrainage is to lay a line of terra cotta tile three or four feet deep on one or both sides of the roadway. The tile should be at least four or five inches in diameter, and laid on a uniform grade. The tile drain satisfactorily when the fall is only one inch per 100 feet.

In special cases across swampy country, a corduroy or mattress foundation, covered with a deep fill of gravel or large stone has given satisfaction.

SIDE DITCHES.

The side ditches are to receive the water from the surface of the traveled way, and intercept water that might otherwise flow from the side hills upon the road. The ditches should be on a uniform grade, in order to admit of the water flowing readily into culverts or entirely away from the road. Ordinarily they need not be deep; but should have a broad flaring side toward the traveled way, to prevent accident if a vehicle should be crowded to the extreme side of the roadway. The outside bank should be flat enough to prevent caving.

When the grade on earth roads is over $4\frac{1}{2}$ per cent, the side ditches are apt to wash deeper and wider so that the width of road is seriously decreased. In extreme cases, the bottom of the ditch should be paved with stone. On side hill or mountain roads, catch-water ditches should be cut on the mountain side above the road, to cut off and convey the drainage of the ground above to the neighboring ravines.

Instead of a system of underdrainage for a road over flat swampy country, the practice in some sections is to raise the subsoil above the water level by making a fill with deep ditches on each side.

SURFACE DRAINAGE.

The surface drainage is provided for by crowning the surface and keeping it smooth. The slope from the center to the sides should not be so flat that water cannot easily reach the side ditches, or so steep that vehicles turn out in passing each other with difficulty and also the side slopes will be washed into small gullies. The slope from the center to the side should vary, for earth roads, from one-half inch to the foot to one inch to the foot. If the surface is well cared for, one-half inch to the foot is advisable. As a general rule, the harder the surface, the less crown is required.

The crown should be greater on steep grades than on the more level portions, to prevent water running down the length of the road. Also, there is more reason for a greater crown for a road on a level than on a slight grade.

Drainage should often be the determining factor in the location of roads. Thus, other things being equal, a ridge route is far more desirable than a valley route. Also a road located on gravelly soil may be expected to remain dryer than one located on retentive soil.

The type of construction of a road surface is often made much more expensive in places where drainage is apt to be bad. Thus, a telford pavement of large stone carefully placed must sometimes be built instead of the ordinary macadam.

It will not be inappropriate here to say that the advantage of proper drainage led to the discovery by John London Macadam of the macadam road to take the place of the expensive type of construction used by the Romans. Macadam's idea was that a well drained foundation and a rigid and waterproof covering will withstand any load, and that idea has not changed up to the present day.

If it were not for the destructive effects of water, the maintenance of roads would be an easy proposition.

County Highway Bridges.

By J. N. AMBLER, HIGHWAY ENGINEER OF WINSTON-SALEM.

Except in a few localities, the popular interest in "good roads," which is so widespread at the present time, did not exist, even as far back as fifteen years ago. At this time, however, there are but few counties in the State which are so bold as to put themselves on record as not favoring good roads, or as being indifferent to the benefits to be derived from them.

Roads are now being built which can take care of the heaviest modern traffic, such as motor cars, motor trucks, steam and gas tractors, and other heavy machinery.

Have the highway bridges of the country kept pace with the movement for good roads? The fact that they have not is notorious, and many of the best highways today are crippled in their usefulness by the fact that there has been little or no appreciation among county officials that the bridges should be adequate to carry the heaviest traffic which will go over the roads.

Since the old adage that the strength of a chain is no greater than that of its weakest link, applies preëminently to this question, a little reflection will show how utterly illogical it is to spend many thousands of dollars in bond issues for modern roads, while even a single bridge, let alone the great majority, are insufficient in capacity to carry modern traffic with proper safety.

At the present time the most common type of road roller, with its coal, water, driver, etc., will weigh some 21,000 to 22,000 pounds. Heavy steam and gas tractors will weigh fully as much, not counting the weight of a train of wagons which is often attached to them. These weights are also approximated by present day motor trucks, and the weights and loadings of this style of vehicle are increasing. While the 30,000 pound road roller is no longer in common use for highway work, in view of what has been said, it does not seem wise to design bridges for a concentrated load less than that which this machine would give, not only for important highways, but also for highways of secondary importance. Over and above this, an allowance of 25 per cent of the live load, for vibration and impact, should always be made. The tendency is undoubtedly toward heavier loadings in the future.

The fact that bridges have been and continue to be built in violation of the demands of existing, as well as future conditions of traffic, is partly the fault of the counties themselves, and partly of the bridge companies.

With the counties, money has been all too scarce, and interest in, and appreciation of the bridge question almost entirely lacking, up to the present time.

Now the more progressive counties are beginning to realize that the old system of letting bridge contracts is illogical and unbusiness-like, and that good results are not likely to be obtained under it.

Under the old system, the only question which had any bearing whatever on the case was "what is the cheapest bridge which can be built from the near bank to the far bank of the stream."

Loadings were not considered, proper unit stresses were unheard of, proper foundations were disregarded, adequate width was of no consequence and good looks was a matter of amusement, while the floor system and details were not worth thinking about. In other words, nothing whatever was involved in the entire question but cheapness.

Often the price was fixed in advance by the commissioners themselves, and bridge companies were told that in no case would the county pay more than \$2,000 for the bridge. Possibly an adequate bridge would have cost \$3,000 or more. Now the bridge companies are met with a choice between building the bridge so cheap that they may still make a profit, or else avoiding all such cases, and, as a result, going out of business.

Of course the first alternative is the natural one to be chosen, and then the question of skinning steel, skinning masonry, and skinning the capacity of the bridge is in order.

Now, there are certain limits below which reputable bridge companies will not skin either steel or masonry, while irresponsible companies do not seem

to recognize any such limit. The writer once heard the representative of a company, known for its cheap work, boast that his company could put up a bridge as cheap as any set of county commissioners could desire.

In support of this claim, he exhibited a large batch of blue prints, which required only a casual examination to see that his boast was thoroughly substantiated.

In such bridge lettings as have been described, the county commissioners were admired by their constituents as astute business men, who could out-trade the bridge men. Imagine a county commissioner, who knows nothing whatever of the tricky business of building bridges, getting the best of a bargain with an unscrupulous bridge company; particularly when the bridge company has both the designing and constructing the bridge in his own hands, not subject to any check on either, unless possibly that of the county surveyor, who, by virtue of his office as the only technical man in the county, is, therefore, supposed to know all about bridges.

In other cases, where the bridge was a large and important structure, enough bridge men would be present at the letting to give the air of fierce competition.

These gentlemen would have to be introduced to each other, and then each would proceed to bid on his own plans, and also on those of his competitors, until the writer has seen a confusion result, from which it would have been hard to extricate the interests of the county. Little did these commissioners suspect that under all the arguments and personal clashes between the bridge men, an understanding had been reached the night before in a nearby city, under which it was decided which company would get the contract, and that at a price sufficiently higher than a proper cost of the bridge, to allow of a snug sum to be divided up between all the "boys present."

In other words, a first-class "pool" has been pulled off over the good and unsuspecting commissioners.

At the present time there is undoubtedly competition of every character, proper and improper, in the case of small bridges, which, when unchecked, results in the skinning already explained. How far real competition may be had in the case of a large and important bridge is doubtful. It doubtless depends upon how the various companies are circumstanced at the time of bidding.

Who is to blame for this deplorable state of things? Bridge companies are certainly to blame for a pool, or any other deception, and for much of the faulty designing and construction. There are extenuating circumstances, however. They say that as long as county commissioners want only cheap bridges, they have to build them, or else go out of business, and that other practices have been forced on them by the counties. The writer has known of several instances where they have been treated with shameful injustice. In the writer's opinion the blame rests very largely on the county commissioners; also with extenuating circumstances. Commissioners should be men of sufficient intelligence to realize that bridge design and construction is a very highly technical matter; so technical as to be entirely beyond their comprehension, and should be of sufficient business experience to know that they cannot beat bridge men at their own game, a game entirely in the bridge men's hands.

Some counties have men of the intelligence and ability to appreciate these issues and who are willing to serve as county commissioners, and to them

we should look for a gradual emancipation from the present practices in bridge building.

The day for "good bridges" as an important factor in the movement for "good roads," is beginning to dawn.

Bridge companies act as engineers in designing the plans which they offer, and as contractors in building them. This places the entire matter in the hands of the company, and ordinarily the counties' interests are not represented at all, certainly by any one who knows anything whatever of bridge design and construction. Every one should know that no amount of business ability in the commissioners will take the place of technical training and experience.

In the early days of bridge building there was some excuse for the companies acting as engineers and contractors, on the same job. Bridge engineering was in its infancy; there were no adequate bridge courses at engineering colleges, and no laboratories or testing equipment for experimental work.

The bridge companies developed these subjects, and are primarily responsible for the present state of knowledge of designing and constructing bridges.

At present, however, a number of institutions offer highly practical courses in bridge engineering, and while, because of lack of demand, there are not enough engineers in the country at this time who are sufficiently experienced in bridge design to handle the bridge work everywhere, their number is increasing, and this is a great step in the right direction.

Where such engineers can be had, there is certainly no more reason why bridge companies should do both engineering and constructing, than that water works, sewer or railroad contractors should do it.

The disadvantages of the present system will never be removed until counties employ competent and experienced bridge engineers, independent of affiliation with all bridge companies, to design their bridges and supervise their construction.

All cities, who know anything of public works, as well as railroad companies and other corporations, feel and know the importance of having the services of a competent, disinterested engineer, acting in their service, and to their interests, and will not do work on any other basis.

To allow one and the same person to be both engineer and contractor, is illogical, unbusinesslike and not necessary. No certain or economical results in the interests of the counties are likely to be obtained in departing from the experience of cities, railroads and the larger corporations in this respect.

They have found that the small cost of engineering service is abundantly justified, and all are large employers of engineers.

How unlikely is it therefore, that counties, with less knowledge and experience will be able to improve on their methods, and still persist, from force of habit, in pursuing a course contrary to all business experience and the dictates of ordinary common sense.

The question may now be asked, in what respect will an engineer be able to help a county with a proposed bridge? I will answer categorically that if he is competent by training and experience, he can help in the following definite ways:

- (1) In assisting them to select the site of the bridge. The importance of the traffic will determine the general situation of the bridge, but the actual

spot is best determined by the engineer, in view of length, foundations, and proper approaches at the ends, from the highways on either side.

(2) Having agreed upon the exact location, the engineer should then be instructed to make a precise survey. This will show the position of rock abutments, if any, the banks, rock ledges for piers, etc.

Accurate levels should be run over the center line of the bridge, as already staked out.

These should show the elevations of the surface of water, bottom of river entirely across, top of banks, and the slopes of the hills for some distance beyond the ends. Soundings should show the position of rock, and the highest known flood level should be ascertained and shown.

(3) With the map and profile prepared from this survey, the engineer is enabled to determine the best and most economical arrangement of spans, the type of spans best suited to the conditions, as well as the proper elevation of the bridge to escape floods.

He can also determine the proper width and height of the bridge, and the loadings for which it should be designed, as well as the safe allowance for wind and flood current. He then proceeds to work out what the stress in every separate member of the bridge is, not only for the dead load and wind load, but for the most unfavorable positions of the live load. He then works out the sizes and cross sections of the steel work to meet these stresses with safety.

Plans for the piers and abutments are worked out, and complete specifications for foundations and superstructure are made.

In the case of concrete arch bridges, the procedure is similar as to its object and result.

(4) The engineer can be of great assistance in letting the contract.

Having figured up the amount of material in the bridge, and applying current prices, he knows what the bridge ought to cost. The county commissioners have no means of knowing what the bridge ought to cost, while the bridge salesmen do know. When the county is represented by a consulting engineer, who also knows about what the bridge should cost, it is likely that a great saving will be accomplished.

If the bids on, say a steel bridge, are all unreasonably high, the engineer suspects a "pool," and is in a position to advise the county as to the practicability of building a concrete bridge, a bridge composed of short one-beam spans, or even a wooden bridge of approved type. Since concrete bridges are built by an entirely different class of contractors, and one-beam bridges can be made in any machine shop, and a wooden bridge can be built by any building contractor of experience, the county does not have to fall victim to a pool of bids.

The writer knows no other way of handling a pool as effective as to be independent of those making it.

Now, the other extreme of cut-throat competition on small bridges, resulting in giving the contract to the most unscrupulous skinner of steel, is also avoided, because the companies are all bidding on fixed plans and specifications prepared by the engineer representing the county. His design is intended to be the most economical that *should* be built, not the cheapest that *can* be built. The assistance of the engineer will also save much confusion to the counties in his telling them what bids are irregular and improper. This is also a protection to the reputable bridge companies, as it insures

them a square deal, removing the improper advantage that the shyster would have over them under the old systm. If the practice recommended were pursued generally, it would do much to remove the low trickery and rascality which has often characterized bridge lettings.

Bridge building would be on a businesslike basis, and the confidence of the bidders that they would all be treated exactly alike, without fear or favor, and would get a square deal, would tend to lower the cost of bridges everywhere.

(5) After the contract has been let and signed, the engineer should be employed to give necessary supervision to construction. Since the foundation work is of the utmost importance, and lends itself so easily to deception, by insufficient care in preparing the subfoundation, leaving out cement, and putting in bad sand, and in many other ways, an inspector, working under the direction of the engineer, should be on the work at all times while the masonry is being put in; while the engineer should visit the work at intervals.

In the case of a concrete arch bridge, the most careful and persistent inspection and supervision are necessary. The fact that this supervision has usually been lacking, accounts, in the writer's opinion, for nearly all the cracking up and more or less partial failure of so many concrete bridges. Since it is impossible to tell much about concrete after it is finished, the only businesslike thing to do is to see that it is put in properly at first. In no other way can the advantages of this material be realized.

The steel work does not require constant supervision, but should be visited by the engineer at intervals, before painting. Since we assume that the bridge company's shop drawings have been approved by the engineer, and certainly in the case of an important bridge, an inspection covering the chemical and physical character of the steel has been made at the mills and shops, by one of the independent inspection bureaus, it only remains to be seen if the various members are of proper strength; that is, that they have the sizes and weights shown on the plans, and that the work is properly erected. The weights of steel can be determined by the engineer by means of a pair of calipers, and comparison with the detail thickness and other dimensions given in the mill catalogue.

The painting should be carefully specified in the plans, and inspected in the field. Railroad companies generally buy paints subject to the specifications and tests of their chemist.

An entire paper could easily be given to this subject. If practicable to apply the test, the bridge should be actually tested with the heaviest load for which it is designed.

The engineer, when satisfied that the bridge is properly built, and that the contract has been complied with, in every respect, should so certify to the county commissioners, and thereupon they should pay for the bridge promptly. The delays and difficulties in getting their money are serious grievances of which bridge companies complain. If, generally, they are treated in a fair and businesslike way in this respect, they could bid closer, and much money would be saved throughout the entire country.

Summing up the entire matter, it should be stated that building bridges is a business—a highly technical business, and to get businesslike results, an engineer, who is simply a technical business man, should be employed to assist the county commissioners, exactly as they employ a lawyer to assist them in their legal business.

It is foolish to build bridges out of keeping with the roads on which they are situated, and which will not handle present and future traffic demands.

Since county commissioners cannot be expected to know how to design or construct bridges, any more than they can be expected to know how to handle a legal battle, it is logical to employ some one whose training and experience enables him to assist them to get safe, sure and economical results with the bridges of the county. It is reasonably sure that no such results can be depended on under the present system of seeing who can prepare the cheapest, and, therefore, weakest design.

The writer wishes to see a realization by all counties of the fact that past conditions should be, and can be remedied, that all bridges should be designed by competent engineers who represent the counties, that all bridge companies should bid on the same basis, and no sneak bids be received, or other features allowed which would tend to destroy the confidence of the bidders that they are being treated with perfect fairness, and that the construction work be supervised and accepted by an engineer, and the bridge companies be paid promptly, and in full.

The officials of several of the most reputable bridge companies, with whom the writer has discussed the situation, have expressed their belief that it was not only best for the counties to have their plans prepared by an engineer, provided he was competent to design bridges, but also for their companies, as a reputable company is usually well equipped with machinery and appliances and with their organization can put in a lower bid on a fixed set of plans, than the shyster can.

In other words, this plan, if carried out, would put a premium on the company best equipped to do the work, rather than on the shyster who is poorly equipped.

It goes without saying, however, that the plan, as outlined, will be fought bitterly by the shyster, because it is an invasion of his field of activities, and tends to creating conditions which will take the premium off of his methods. When he is confronted with a set of plans and is told that his bid must be on them, or on none, he is deprived of the advantage previously enjoyed of preparing a plan of his own so cheap and weak that his reputable competitors (who have sufficient tangible property to be liable) cannot follow him.

He is also deprived of designing the bridge to use such old remnants of steel shapes of various sizes and character as he may have left on his yards.

There is nothing for him to do but to attack the ability of the engineer, and see if he can't get in such close personal touch with some of the commissioners, who think that engineering is nothing but nonsense, anyway, as to create a doubt in their minds as to the plans.

Sometimes the opposite course is pursued, the engineer is highly praised, and the design is pronounced a most superior one indeed. However, it is pointed out, "You commissioners can't afford to build a bridge like that. Why we can put up one for not much over half of what that one costs." They speak truth, for they not only can, but will do this very thing if allowed to do so.

A good answer for the commissioners to give is that our engineer states that he also can design one to cost half as much as this, and if necessary, could design one even lighter still, so light, in fact, that he would not dare

drive over it himself, when completed; but he states that the bridge, as designed, is as light a one as we should build, in the interest of the people.

While the course outlined in this paper is aimed primarily at benefitting the counties, it cannot fail to be of benefit to all bridge companies who take pride in their work and are willing to give a square deal themselves.

For one to oppose a movement intended to put bridge building on a more honorable and businesslike basis, with fairer and more certain results, for the company and county alike, would seem to the writer to be an admission by the company, that they were not in that class to which such an appeal could be made.

The writer will never cease to bring the importance of "Good Bridges" to the attention of county officials, as far as his limited ability with word and pen allows, and if this paper has in any way awakened interest in this long neglected subject, he will be satisfied.

Culverts.

BY R. T. BROWN, HIGHWAY AND ROAD SUPERINTENDENT, ORANGE COUNTY.

There has been such excellent material on the subject of culverts, published by the U. S. Office of Public Roads, by many of the State Highway Departments, by the manufacturers of the various kinds of culverts, and in the road magazines that it seems rather useless to attempt to bring out anything new or of especial interest on the subject.

For convenience, culverts are classed under the following heads:

1. Wood Culverts.
2. Stone Culverts.
3. Brick Culverts.
4. Vitrified Pipe Culverts.
5. Concrete Culverts.
6. Metal Culverts.

This classification is probably not arranged in point of relative merit, but rather in the order of development, which is also in a general way the order of merit.

WOOD CULVERTS.

By some builders of culverts the wood culvert is disregarded as a thing of the past and not of sufficient worth to be used in this day of more enduring forms of construction. By others it is used as the chief means of drainage. I take it that neither extreme is practicable in all cases. But I do think that wood culverts in any road that presumes to be a permanent way of travel for the public should be discarded as rapidly as they may be economically replaced by something more lasting. For temporary purposes in light construction and for repairs of accidents to culverts on roads that must be kept open continuously wood culverts may often be used to advantage until material can be obtained for a more enduring type. However, the temptation is to leave the wood culvert in just as long as it will hold together. This is especially true of those in roads kept up by the spasmodic kind of overseer we have in this part of the country. He lets all the culverts get in just as bad condition as the public will endure, and then takes a spell at repairing them. He has not previously provided any material for the needed repairs

and consequently he must go to the nearest saw mill and scrape up enough stuff to make his repairs and let the sawyer make out a bill for whatever he thinks he ought to have for it.

STONE CULVERTS.

Under the heading, stone culverts, I would include those of dressed or faced stone and those of rubble masonry laid in mortar. (And I would not recommend using stone in any form in a culvert without its being held in place by means of reasonably good cement mortar.) An exception might be made in the case of a drain of large and small stones sometimes used to carry the stream from a very small spring, if this may be classed as a culvert.

In ordinary highway construction, where the work is often done without the constant supervision of an inspector, and usually by contractors whose chief desire seems to be to use as little cement as possible, it is not advisable to build stone culverts of greater than four or five feet spans. On scenic highways and those on which it is desired to keep the artistic features prominent, stone may be used with good results if it can be obtained in proper shapes and if the necessary care is used in the construction.

In all cases where there is much fall in the stream bed and the foundation is of such a nature as to erode to any considerable extent, the waterway of stone culverts should be either paved with broad, heavy stones or grouted to a depth of five or six inches. This paving should extend some distance below the end of the walls, so that they will not be undermined at the outlet.

I have found that a fairly good and economical manner of constructing the walls of small stone culverts and also abutments for small bridges is to build up the faces of the wall with the larger, better shaped stones and fill in the center with small stones and grout, that is, rather thin cement mortar. This avoids the use of forms and at the same time gives a pleasing looking face to the wall if the work is properly done.

One fault of many stone layers is that they want to skimp the mortar in the body and the back of the wall, and then point it up carefully on the face to make a good looking job. It would be better for the culvert if they put the extra mortar in the back instead of on the outside; for when there are voids in the stone at the back and the front is plastered up so that the water that gets in from behind can not get out at the face, the wall is very likely to be destroyed by the freezing of the water.

Unless plenty of large stones can be obtained, stone box culverts should not be built over three or four feet spans. Above this size the top should be arched and supported until the mortar is thoroughly set. Unless the foundation is of solid rock, the bases of the walls of an arch culvert must be spread far back into the fill to avoid settling from the thrust of the arch, and the consequent cracking of the culvert.

BRICK CULVERTS.

Brick culverts are probably suited to parks and private grounds better than to use in general road construction. Unless a very good grade of brick is used and great care is used to have all voids filled with good cement mortar, this type of culvert will quickly disintegrate. It is not an unusual thing to see the headwalls of a brick culvert beginning to tumble down in a few years after they are built. On account of the uniformity of size and color, brick can be used to give a very artistic construction. But if the work is poorly done,

a brick headwall is about the cheapest looking thing one could see on an improved highway. The same thing may be said of a brick culvert as of stone, that the failure of a single brick may mean the collapse of a large area, and may necessitate the reconstruction of the whole culvert.

One strong objection to the use of brick culverts is the time required to construct them even when of small area. Often a culvert is needed at once so that grading can proceed over it immediately. It is, to say the least, risky to allow earth to be dumped carelessly on a newly constructed brick culvert. It should, instead, be placed by hand and thoroughly rammed until a layer of sufficient thickness is obtained to carry the shock of a concentrated load.

VITRIFIED PIPE CULVERTS.

Under certain conditions, vitrified pipe makes a very good and permanent culvert. Within itself, well burned terra cotta is practically everlasting. It is not affected by acids or alkalis that are present in ordinary soils. It presents a smooth surface, thus offering little resistance to flowing water. It is of sufficient hardness to resist considerable eroding action of sand in the current. But it will break. It breaks when being loaded on the car, while in transportation, when being unloaded, when being hauled to the culvert site, when being rolled into the ditch, and when a heavily loaded wagon jumps over a little rock and onto it.

But if it is installed under a fill of the requisite height to give it sufficient protection, and is otherwise properly placed, it makes a lasting culvert. This is very important as vitrified pipe is entirely unsuited for use near the surface both on account of liability to crushing and to freezing. It has been my experience that most of the failures of vitrified pipe culverts have been due to improper installation rather than to worthless pipe. Many road builders seem to think that clay mud is a perfectly good filling for the bells after the pipe is in place. I have seen many supervisors have rock put all around and on top of the pipe to hold it in place and to prevent wagons from getting to it and breaking it. No more absurd things could be done. The clay washes out of the bells, the rocks allow the water to run around the pipe, thus giving it every opportunity to wash out the roadbed, and one little rock gets in the exact position for the wheel of a heavily loaded wagon to drop off a larger one and punch a nice hold in the pipe. I have seen cases in which the water ran out so fast at the leaks that none came out at the lower end. Certainly this was not the fault of the pipe, except in so far as it has too many joints.

Unless the foundation under a vitrified pipe culvert is pretty uniform and the earth is properly rammed underneath, it is likely to settle unevenly. This often allows silt to accumulate, with the result that the pipe is finally clogged. I take it for granted that no one in this body would install a vitrified pipe culvert as I saw one placed in a nearby town recently—with the bells down stream. Even the best grade of clay caulking would soon be washed out of that. Of course, if the joints were all filled, as they should always be, with good cement mortar, this arrangement might hold, but it would be much better from any consideration to have the bells upstream.

CONCRETE CULVERTS.

Concrete is, of course, the most adaptable of materials for culvert construction. It can be used for as small and as large spans as desired, if properly reinforced. It can be made as artistic as funds available will permit. It can be made as strong and rigid as the circumstances require, and it is probably the most permanent of any of the types mentioned.

The chief reason for its not being used more than it is at present is its cost. It is usually necessary to construct forms for the culvert before making the culvert, so that many builders prefer to let one building do, and hence use some other material. When the use of metal forms becomes more general and work can be so arranged that a few sets of forms can be used over large areas, such as whole counties, the construction of concrete culverts will become more common. There is an idea among many township supervisors that concrete is a material to be used only by the highly skilled laborers, and they are afraid to attempt its use. As a matter of fact, the labor required for concrete construction need not be any more skilled than that for moving dirt and laying pipe, but to be properly used it needs faithful labor. After learning something of the properties of different kinds of sands and the proper proportions for various purposes, the matter resolves itself into exercising the necessary care to get the mixture uniform and depositing it in properly built forms. The one great trouble in concrete work is to get it mixed thoroughly. I once gave a man who was mixing for me a rule by which to get it thoroughly mixed. I told him to turn it until he was absolutely sure that each grain of sand was coated with cement and each piece of stone covered with mortar and then to continue as much longer as he had had been at it. Not only should the materials be well mixed before water is added, and while it is being added, but it should also be stirred frequently while being deposited in the forms.

While concrete is very hard to resist wear and strong to stand crushing stresses, it is well known that it does not resist tensile or bending stresses very well. As the top or slab of a culvert must carry bending stresses, provision must be made to carry them by means of reinforcing metal. The form of reinforcing steel most convenient for use in small culverts is that of round bars or some of the patented types of deformed bars. Expanded metal is also used in connection with rods in many sections of the country; but, if it is desired to use some large stones for filling, the mesh metal is likely to be in the way. Then, again, it is easier to get the ordinary laborer to place rods properly and to keep them there than is the case with woven or mesh metal. A principle to be always remembered in placing reinforcing steel is that it is to be nearest the side towards which the slab would bulge when weight or any pressure comes on it. Recently a man who is working on our forces wanted to bend the half-inch reinforcing rods upward in the form of an arch. If the rods had been as strong as railroad rails, his method would have possibly served, but with half-inch rods it would have been of absolutely no value unless it were to hold the two pieces together after the slab had broken.

As we have no means of crushing stone for our concrete culverts except by hand hammers, I have built many of the walls of my culverts as simple rubble masonry walls; then built a form an inch or so below the tops of the side walls on which to construct the slab. I allowed the steel rods to project onto

the tops of the walls and, when possible, to anchor in them. By leaving projecting stones on top of the wall, the slab can be very thoroughly bonded to it. It is well in using this form of construction to place short pieces of rods in the wall when finishing it and then to bend the cross rods around these in the wall.

Of course, the slab can be made thick enough to carry any reasonably heavy load without the use of reinforcing steel, but it is more economical to use the steel, and there is greater safety in using it than in depending on the concrete alone to carry all stresses.

Concrete pipe, made similar to terra cotta pipe, is now being used to some extent for culverts. It has the advantage of being stronger than terra cotta in addition to the qualities they possess in common. If it is known long enough beforehand what sizes will be required, molds can be bought or made and the pipe manufactured by the user. If a good quality of sand or of stone screenings is available, this type of culvert can be made at a reasonably low cost. The pipes should be protected from the sun while curing, and should not be used for at least thirty days after being molded.

Not having used this type of culvert, the writer is not prepared to give comparative costs. The cost of hauling and installing is obviously about the same as for terra cotta under similar conditions.

METAL PIPE CULVERTS.

Cast iron pipe has been used by railroads and in some other places for many years. Its great strength and rigidity make it especially suited for use under high fills and in places where there are heavy concentrated loads to be carried, and its durability warrants its use in construction that is intended to last indefinitely. Its cost and great weight, however, prevent its general use in highway construction except under very high fills. There are now a few firms who manufacture ribbed cast iron pipe that has practically the same effective strength as the smooth pipe and is at the same time much lighter. There would rarely occur in a single county enough cases where cast iron pipe would be required to justify the purchase of it in car lots.

The manufacture of culvert pipe from corrugated sheet metal is of comparatively recent origin. It has been called forth by the widespread interest in road improvement that is also of recent development. In fact, this type of culvert has not been in use long enough and under sufficiently varied conditions to make us perfectly sure that it will last as long as is claimed for it. But in spite of the lack of information, based on long experience, corrugated metal culverts are being used a great deal, not only in highway construction but also in railroad, street railway, and interurban lines.

There are reasons to believe, and the information we have thus far obtained from experience tends to support this belief, that if culverts are properly constructed of the most nearly pure iron obtainable, their life will be sufficient to justify the original cost. To make sure that these culverts shall be of the highest efficiency, as much care should be exercised in the mechanical construction as in the selection of the material. It would be folly to put into a culvert metal that would last a hundred years and to rivet it together so poorly that it would be broken by the settlement of a heavy fill, or to use such light gauge material that it would be easily crushed. It is also quite important that the rivets, bolts, and connecting bands or angles be of the

same material as the body of the culvert. All parts of the culvert should be coated thoroughly with spelter; for if the metal will endure because of its rust resisting qualities, it will be still further protected by the spelter.

Corrugated pure iron culverts probably combine more desirable qualities than any other one type, though some of these qualities are not quite so characteristic of this type as of some others. Thus the corrugated culvert is light, strong, easily and quickly installed, can be secured in various lengths, stands handling fairly well, is water tight when properly laid, can be taken up and moved if necessary, and, so far as we know, lasts for a considerable period. It can be quickly unloaded from the car and hauled in large quantities at a load. The ease of installing it and its resistance to crushing allow it to be placed immediately ahead of the grading and the fill dumped on at once. This is an especial advantage when the work follows an old road that must not be obstructed too far ahead of the grading force.

Steel has been used to some extent for corrugated culverts. It is entirely unsuited for this purpose and should not be used under any circumstances for permanent highway work.

AREAS.

One of the most important considerations in regard to any culvert is the area of its opening. Many rules and formulas have been devised for giving the approximate area of culvert required for various drainage areas and conditions. Some of these, when compared, give such widely varying results that they should only be used with a full understanding of the conditions for which they are suited, and judgment must be used to adapt them for local conditions. Dickens' formula for the maximum run-off in cubic feet per second for various kinds of surface is given below. After the probable run-off is computed, the required area of culvert can be found from tables furnished by various manufacturers.

Dickens' Formula.

$$D = \frac{4}{C \sqrt{M}}$$

D = discharge in cubic feet per second.

C = 200 for flat country; 250 for rolling country; 300 for hilly country.

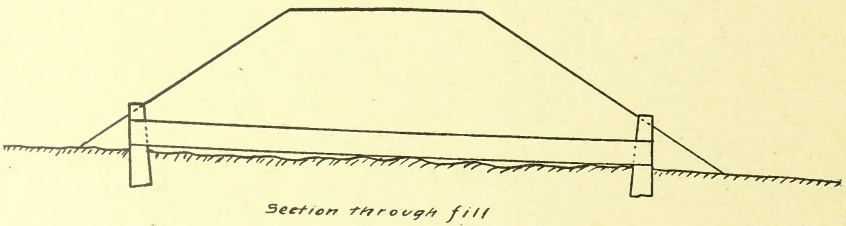
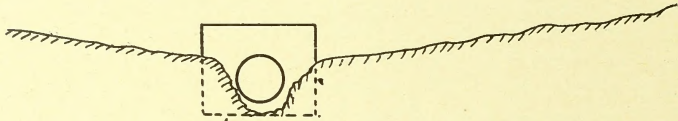
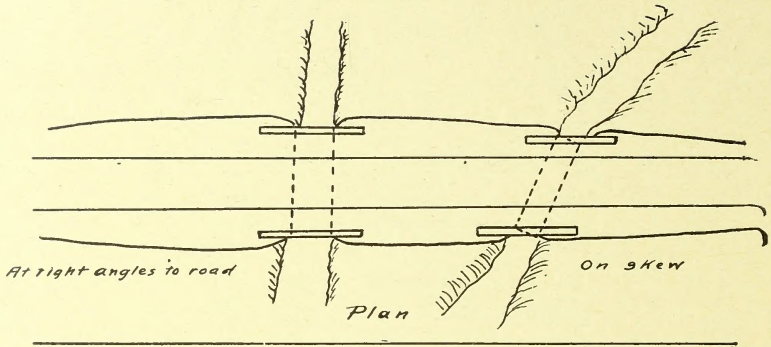
M = area in square miles, or acres divided by 640.

The safest guide for the required area is information obtained on the ground from existing culverts and bridges and from high water marks. It is better to be on the safe side in designing culverts, as the areas are likely to be partially closed up by rubbish and the capacity thus rendered less than that for which it was designed.

LENGTHS.

The required length for any particular culvert can best be determined from the ground after the slope stakes are set. It depends not only on the height of the fill, but also on the angle of the culvert with the roadway. When possible, the culvert should be at right angles to the roadway. The length of pipe culverts should be from three to five feet less than the distance from toe to toe of the fill along the direction of the culvert. This will allow the headwalls to set back in the fill, as shown in the illustration for headwalls.

For the purpose of a preliminary estimate, the following method is con-



SKETCHES of HEADWALLS
For Pipe Culverts

FIGURE 15.—Sketches for Headwalls for Pipe Culverts.

venient for obtaining the length. Find from the profile the distance from the top of the fill to the top of the culvert. Take twice the horizontal distance on the slope for this height of fill and add to the width of fill from shoulder to shoulder. A cross section sketch of the fill may be drawn to scale and the required length at any depth scaled from this sketch. If the culvert is on a skew, the length obtained above must be multiplied by the co-secant of the angle it makes with the center line.

HEADWALLS.

I think it may be laid down as a general principle that all pipe culverts should have a headwall of either concrete, stone or brick at the inlet end. If the culvert is under a shallow fill or at the intersection of two roads, it should have walls at both ends to prevent crushing of the ends by vehicles. I use stone headwalls at each end on all my culverts. They tend to prevent clogging of the culvert by the fill over-running the ends of the pipe, and to keep the water from running around the outside of the pipe and washing out the fill. I have seen in more than one case the inlet end of a corrugated pipe lifted bodily out of place by the force of the water. This would not have occurred if headwalls had been built.

The pipe should be of such length that the headwalls will set back in the fill, so that the outside of the wall will be within the toe of the fill. It is unsightly to have a wall standing like a tombstone clear out beyond the toe of the slope. I give herewith a sketch of the general design used in this county. (Fig. 15.)

RELATIVE COSTS.

At first, the cost of wood is probably somewhat cheaper under ordinary conditions than terra cotta. But when the frequent renewals and the possible inconvenience to traffic by failure of the culvert are taken into consideration, I think the additional cost is justified, even when a small amount of money must be expended over a large amount of road.

The cost of stone and metal culverts is higher, but in new work, especially, some of these types should be used, unless conditions are suitable for terra cotta.

The cost of each of the types for the equivalent of a twelve-inch circular pipe runs about as follows: (This is for the culvert f.o.b. nearest station.)

Wood, including constructing.....	\$.20 to \$.25	per ft.
Vitrified pipe	.20 to .22½	
Stone, complete in place.....	.50 to .75	
Concrete, complete in place.....	.75 to 1.00	
Cast iron f. o. b.....	1.00 to 1.25	
Corrugated iron, f. o. b.....	.50 to .65	

Owing to the different costs for hauling, the ratios of costs for the different culverts at the site will be somewhat different from those given above. This is where the difference in price between wood and terra cotta comes in.

From the records on work, on one job now being done I find that for corrugated pipe the cost per foot for installing complete with headwalls averaged slightly over 40 cents per foot. This includes hauling pipe and cement twelve miles, cost of sand and cement, hauling sand and stone, cost of labor and supervision. The sizes on this job range from 12 inches to

30 inches, about one-third of it being 12-inch pipe and one-sixth each of the 15-inch and 24-inch sizes. This covered a distance of three miles on average hilly country, at a total cost of about \$260, or at the rate of \$87 per mile.

Road Machinery Required in County Road Construction.

By N. C. HUGHES, JR., HIGHWAY ENGINEER AND SUPERINTENDENT HIGHWAYS,
HALIFAX COUNTY.

Mr. Chairman and Fellow Road Engineers:

For the past two days we have listened with much interest and profit to able discussions on the subject of Highway Construction, from the standpoint of location, drainage, use and class of material, and that of economy in construction, and methods of finance.

We come now to the discussion of the subject of road machinery required in county road construction, to which I invite your attention and indulgence. It shall be my purpose to make the discussion as brief as shall be consistent with covering the ground as fully as I can.

No road engineer or superintendent has ever undertaken the problem of road construction, I dare say, without coming to know that the class and variety, and the quality of that variety, of equipment necessary in road building are very essential factors in economically as well as constructively effecting results. The time is in the distant past, let us hope, when merely a dump car or one-team wagon, with shovels, hoes, and axes, and now and then the use of a one- or two-horse turning plow fulfilled the necessary equipment of the so-called building of roads. Experience has taught those who have, as we may say, "been to the grind," that the essential and all-round efficient equipment for highway construction is that composed chiefly of teams and machinery, with, of course, the labor required to operate both. It is now no longer contended that the same results can be accomplished in the same length of time and under the same conditions, with man power as with mule power and machinery. Therefore, when the proposition arises for the removing of earth either for excavating or for embankment or for surfacing material, for the sake of economy and rapidity we resort to the use of the drag scraper or wheeled scraper, better known in the vernacular of the road gang as "scoops and wheelers," respectively, instead of the dump cart or wagon and shovels. It has been estimated that a cubic yard of earth can be removed for a distance of from one to three hundred feet with a scoop, carrying five cubic feet, at from one-half to two-thirds the cost of removal of the same with teams and wagons or carts loaded with shovels, and for a distance of from three hundred to one thousand feet with a wheeler, carrying from twelve to thirteen cubic feet, practically a half yard, at a load, at a cost within the same ratio. The scoops for short hauls as above noted are more economical as a rule than the wheelers, so much being saved both in time in unloading and turning, and in expense of the snatch-team. The wheeler is the more economical when the haul runs from three hundred to one thousand feet, and possibly twelve hundred feet, by reason of the fact that the scoop does not carry enough material at a load to justify pulling it that far. When the haul on material exceeds one thousand feet, generally, it is economy to abandon wheelers for wagons which carry at least one solid cubic yard at a load, and preferably, where the soil over which the hauling must be done will permit, for the automatic dump wagons of from two to

three yard capacity. But since a two yard wagon loaded with earth ordinarily moist will weigh, outside of the weight of the wagon, over two and one-half tons, and a three yard wagon loaded, something over four tons, it is merely a question of whether or not, the distance of haul and the character of the route being taken into consideration, it is feasible for the teams.

In the case of excavation, in order to get at the earth with ease and remove it with rapidity, without undue strain on the loader and the teams, the earth should first be deeply plowed. For this work a four- or six-horse grading plow, with beam of wood or cast steel, should be used. When the proposition is the removal of a stiff red clay, or a clay full of coarse grit or gravel, or a subsoil hard-pan, or a gravel soil naturally close set, it is not only advisable but necessary to loosen up the soil in some way before the plow will take it. To effect this, no tool is better than a four- or six-horse Rooter plow. Both this plow and the grader are also necessary tools when the conditions require the scarifying or plowing-up of an old, hard-set, rutty road bed, regardless of what the natural material in the road-bed happens to be. Sometimes it is possible to remove a sandy or loam soil out of an old road bed to waste, or from a pit for surfacing purposes, without this previous rooting or plowing, but, as a rule, for the teams' sake, even then it is advisable.

Assuming that we are constructing a sand-clay road, and the rough and heavy earthwork necessary in completing the subgrade has been effected by means of the above mentioned tools or machinery, and the surfacing material has been properly placed and well plowed into the subsoil, as the case may require, with the grading plow or a lighter turning plow, the next tool of prime importance for insuring that the mixture of materials and the depth and width of the mixture shall be uniform is the disc harrow. This should have not less than ten discs, and preferably twelve or even fourteen, for the wider the base the more rapid the operation, and the heavier the machine the deeper the cut and therefore the more thorough the mixture. This harrowing also serves to a large degree to fill up an innumerable number of unseen voids and smooth out surface undulations. After this operation, it is always well to run a heavy spike-tooth harrow once or twice over the surfaced portion to more thoroughly mix the soils and even up the surface. This harrow is also very serviceable in dragging out grasses and roots.

This work having been accomplished, the road bed is now in prime shape for the proper shaping-up and crowning. This calls for the road machine. There are manufactured three different sizes of these, one for a two to four horses, one for four to eight horses, and one for from twelve horses to a traction engine. As to the two- to four-horse machine, when used as a two-horse machine, it may safely be said to be impracticable; but when used as a four-horse machine it is very efficient and, in many instances, is more economical than a larger machine. But, as a rule, it is perhaps more economical to use the six- to eight-horse machine, on account of its greater stability, length of blade, and extent of wheel base. In the smaller machine the blade is only six feet long, in the larger one it is seven. Therefore, for shaping-up, crowning and dressing off a road bed, there are three reasons chiefly which are in favor of the larger machine. First, there is less liability of breakage against underground stumps, rocks and roots and less shying off from obstacles of whatever nature. Second, the difference in the amount of road surface covered in the run of a day more than compensates for the small additional cost of extra teams and labor. Third, and not the least

important to the final development of the road bed, is the greater length of the wheel base. It is readily seen that the greater the base the less frequently the machine answers to the little irregularities of the rough surface ahead of the machine when the wheels come to pass over them. And consequently, the result is bound to be a smoother surface throughout the length and breadth of the road bed. On the other hand, in cutting out lateral drains, where only a V ditch is necessary, the lighter machine is just as good and sometimes better, as it is possible to work with it in a smaller space, a condition which very often has to be dealt with. If it be a case of choice between these two sizes, it is, perhaps, advisable to have the larger machine. But the better thing is to have both on the job, for there are times when one is needed where the construction is going on and one where at the same time the roads already finished need redressing. Either one is very effective at times in conveying surplus material for short distances, grading off bumps in the roadway, backfilling a trench from which clay for surfacing has been obtained along the roadside, knocking down a crown that has become too high, and for removing snow from the road bed. The road machine is also indispensable in levelling up subgrades prior to the placing of the surfacing materials. There are some instances where the use of a road machine on an ordinary dirt county road is practicable, but those instances are very much in the minority. As a rule the roads are so uneven and full of hard bumps, roots, stumps and rocks, both surface and under ground, and tufts and mats of roadside grass, that it would cost any ordinary man his religion to try to reshape them, especially with untrained men as drivers and mismatched teams at the draft. It is indeed a mistaken idea that just any old kind of road can be machined and reshaped by the road machine. There must first be done some grubbing and plowing and filling in of low places. To a large degree this same can be said in the use of the road drag on this class of roads. You have only to ask the man who has tried it one time. A Tractor Machine, under certain conditions, may be economically used in road construction. But this necessitates a traction engine at the draft, either steam or gas, preferably the first, since the latter has not yet reached the stage of certainty of operation. But both of these are very expensive machines at first cost. And unless the extent of the work is great enough to justify the sending of the engine to the junk heap after the completion of the work, it is, no doubt, not advisable to load up on such expensive machinery. It is a much easier matter to dispose of a surplus amount of mule flesh, though depreciated in value from usage, at a reasonable price than a second hand traction engine. Yet if it be feasible, a combination Tractor and Roller would not be out of place, since, after the completion of the work, the Roller could be most effectively used in the upkeep of gravel roads, and, in all probability, in that of some classes of sand-clay roads.

And now as to the use of a steam roller in road building. The question has often been asked if a steam roller is not as practicable and even as necessary in the construction of a sand-clay road as in gravel work. From a theoretical standpoint the writer thinks not. If the clay or sand surfacing is placed in layers of from three to four inches and rolled after being mixed with the subsoil, this solid base will, of necessity, have to be partially, if not wholly destroyed when it comes to applying and mixing the next layer. And if the whole amount of surfacing is placed at once, mixed and then rolled, the effect will be to compress it only so deep, leaving, as it were, a cushion

underneath which is subject to the underground moisture and therefore the capillary attraction which is bound to follow. This condition gives rise to a giving away of the top hard rolled surface under heavy travel in an uneven manner, thereby producing rapidly a very uneven surface, and one which is hard to repair. And since, too, experience has shown that, let the mixture of sand and clay be made as thoroughly as is possible during the construction, there has still got to come the puddling to get the desired result, it appears to be reasonable that the use of the roller in sand-clay construction is a useless expense, if not a detriment to obtaining good results. Yet I believe that a steam roller may be used very effectively on a completed sand-clay surface at a certain stage of the game, that is, after it has become well set from the subgrade up to within from one to two inches of the surface. If it is then rolled, after the road machine or drag, a very even and hard surface may be produced. Certainly, however, a roller is most effective, not to say essential, in the construction of a gravel road. Some road builders claim that the compressing of the gravels is accomplished as well with the heavily loaded, wide tired wagons passing over the material already placed as with a roller, and in some instances better. But this is doubtful, since the roller is bound to produce a more uniformly compact surface than the irregular passing to and fro of the wagons.

Experience has shown that, after a gravel or sand-clay road has been completed, and a redressing becomes necessary, the road machine will produce better results for a while than the running of the drag. To illustrate: After a sand-clay road has become cut up a time or two after completion, so to speak, and has just begun to dry out, a vast number of small, hard bumps and lumps appear on the surface, making it very uneven. These are for the most part cemented to the surface, and sometimes stoutly enough so to partially, if not almost wholly, resist the drag as it comes along, and the result is that the drag merely slides over them or shaves them off just enough to make it necessary to re-run and re-run the drag over the same ground. And this can not always be done at times when needed. But the machine will clip off all these rough places, gather up the surplus amount of material from that spot and convey it to some spot where it is needed. But while the split-log or timber drag, or steel drag, with or without lever attachment, certainly is not, as is sometimes thought by many, a panacea for all road ills, and will sometimes do more harm than good, when run at the improper stage of the dampness or dryness of the surface, it is a great benefactor and wonderful discovery, and a tool which has come into the business of road building and upkeep, not only to stay, but to be improved upon, both as to its application and construction. This has already begun to be proven. Indeed, for general purposes, a three blade drag, by covering more longitudinal ground space gives better finish to a road than the two blade. The lever attachment to the steel drag is a good asset, but not, perhaps, essential. Before leaving this subject, however, it is worthy of note to mention the use of the drag upon a gravel road. When run over a hard-surfaced, well knit gravel road it is very harmful to the wearing surface, unless this work is immediately followed up with the roller, to press back into the surface the myriad of minute pebbles which have been either loosened up or dislocated. Where redressing and reshaping of a gravel road is necessary, it is doubtless always better to do this work deftly with the machine rather than with the drag.

In some localities in mountainous or piedmont country, where rock is plentiful and accessible, a rock crusher is a very valuable piece of machinery. And where improved bridge work is being done by convict or free labor this machine is very necessary for crushing the rock to the proper sizes for concrete abutments and arches.

So, too, would it not be amiss to have a pile driver with a hammer weighing from twelve to sixteen hundred pounds, for driving piles in locations where such class of work is expedient.

It is almost needless to mention that barrows, axes, shovels, mattocks, pitch forks, potato rakes, broad axes, cross-cut saws, emery wheels, grindstones, a carpenter's outfit, a small blacksmith's outfit, nails, bolts, washers, repair parts to the machinery, rough repairing material, coils of rope and wire, leather hides, hooks, a supply of dynamite with accessories, an extra harness or two, extra chains of different weights, extra neck-yokes and whiffle trees, one or two small one- and two-horse turning plows, and at least one water wagon, while not the machinery required in county road construction, are certainly very important, if not essential cogs in the machinery to complete an equipment efficient and economical.

To sum up, therefore, road machinery required in county road construction, the following list is suggested:

Wheeled scrapers, of twelve or thirteen cubic feet capacity, known as a No. 2, always equipped with snatch-rods and end-gates, weight about 650 pounds, drag scrapers, of at least 5 cubic feet capacity, known as a No. 2, weight about 85 pounds, back scrapers of the same capacity, two-horse wagons, automatic dump wagons, a six- to eight-horse road machine, a two- to four-horse machine, a four- to six-horse grading plow, weight about 300 pounds, and Rooter plow of about the same weight, a split-log or timber drag, with metal shoes, or steel drag, with or without lever, an eight or ten ton roller, when conditions will justify it, a thirty- or forty-horse power Tractor, and practically all of the accessories above noted.

Finally, as an afterthought, and, perhaps, not of the least moment, the road builder should, by careful study and observation, thoroughly acquaint himself with what tools and road machinery produce the best results under each given condition, and be able to make a practical use of that knowledge by imparting it, when the occasion so demands, to his foremen. He should be able to judge the best constructed machinery and tools, the price sometimes, but not chiefly to be considered. Minutiae of detail of construction of certain machinery is very often a matter of great consideration when facility of operation and durability under hard service is desired; as, for instance, the draft on the team in loading a wheeler, or that of this make of road machine or that. He should be able to know the proper team for given work, and for all the work in general. And, lastly, he should be a good judge of the men best competent to carry on the different phases of the work in hand.

It is possible to make up some statistics on the cost of an equipment such as is outlined above, but this would depend entirely upon the size of the force to be operated, and the amount of funds available for such equipment, based upon the class and extent of work to be undertaken, with a given appropriation.

Road-Surfacing Materials in North Carolina.

BY COLLIER COBB, PROFESSOR OF GEOLOGY, UNIVERSITY OF NORTH CAROLINA.

No State in the Union has a better supply of road-surfacing materials than North Carolina, and each kind is admirably suited to the needs of the section in which it is found. So important is the location of road-making materials in general that many of the excellent European roads shown last night were located with regard to easy accessibility of material for surfacing and maintenance, and we are already finding out in this State that maintenance is every bit as important as the initial construction of our highways.

It is, of course, well known that no kind of surfacing will make a good road where the problem of drainage has been poorly cared for; but where this problem has been solved with success we usually have near at hand all the materials needed for surfacing. It is everywhere recognized that much-traveled roads over which heavy burdens are drawn had best be surfaced with broken stone, while they must not be too hard or too slippery, or too noisy, and as free as possible from mud and dust. Now these conditions demand certain qualities in the stones used, and toughness of material is far more essential than hardness in a road metal, and the cementing and binding power of the material used must be taken into consideration.

Now the igneous rocks, or those that have consolidated from a molten state, possess in a high degree those qualities required in highway construction. Geologists recognize in these rocks two great general groups: the acidic or non-metallic rocks, high in silica, hard and weather-resisting under ordinary conditions, but brittle to the blow of hoofs and of iron-tired wheels; and the basic or metallic rocks, low in silica, and carrying a good percentage of ferro-magnesian minerals, and so exceedingly tough and tenacious that they can hardly be broken with a blow, though regular traffic on the highway grinds from them enough of their substance to serve as an excellent cement.

The acidic rocks are light in weight and light in color, and include the granites and syenites; they are excellent for structural purposes, such as abutments and viaducts and culverts in heavy highway construction, but are too easily pounded to dust, which rain steadily turns into mud, to be of any permanent service as road-surfacing materials. The basic rocks, on the other hand, are heavy in weight and dark in color, and include basalt, diorite, diabase, peridotite, and gabbro, all of which are frequently called *trap* by the engineer, and all having the toughness and cementing qualities requisite in a good road metal.

Trap.—This term is a generally accepted field name for any dark, finely crystalline igneous rock. Trap, or basalt, occurs in long and relatively narrow bodies of rock, which in a state of fusion has forced its way into fissures in older rocks and there chilled and solidified, or it is sometimes found in sheets between the beds or layers of the older rocks, or even in sheets of material poured out on the surface, in the region of our North Carolina brown, red, buff, and gray sandstones, stretching from Granville County on the north entirely across the State and into South Carolina through Anson County. Another exactly similar area extends into the State from Virginia along Dan River reaching as far south and west as Germanton. In these Triassic sandstones, by which name they are known to geologists, the grading of the road bed is relatively an easy task, and nowhere can the right of way traverse so much as a mile without crossing a trap dike. In such a

section we have the ideal conditions for highway construction. Our best macadam roads are all surfaced with this material, the coarser, broken stone being put down first and then filled in and covered with more finely crushed material, and some of these roads have now stood heavy traffic for almost a century. The coming of the automobile into general use has now so modified the problem that some other binder than finely ground trap, well wet down, will have to be found.

In other portions of the up-country and in the mountain regions of the State we have an abundance of basic rock in dikes along every possible highway we could construct, gabbros, diorites, and peridotites, and even granites when fine-grained like the aplites, or where they happen to be free from mica, as the binary granites, may serve as road surfacing materials.

Mica-schist and most metamorphic and crystalline rocks should be scrupulously avoided.

Cherts, or ancient flints, associated with the older limestones of the western part of the State, may render satisfactory service on certain types of road.

Quartzites.—The quartzite found in some of our mountain counties and in portions of Cleveland, Gaston, Lincoln, and Catawba, as well as in parts of Stokes, Forsyth, and Yadkin, are so hard as to be harmful to the hoofs of horses, and so brittle as to become a constant source of fine dust and of mud in wet weather and should be avoided.

Limestones.—The limestones, except when crystalline, make excellent surfacing material for roads carrying light traffic and this is especially true of the shells and shell-rock of our coastal plain region and of some of the magnesian limestones of the piedmont. At several points in the Triassic sandstone areas thin-bedded limestones occur and have been used sparingly with the top dressing to the trap macadam adding greatly to its cementing qualities.

Sand-clay.—The materials for sand-clay surfacing are found throughout the State, and the sand-clay road now promises to be the most satisfactory road we can construct in North Carolina. Good drainage is the first essential to a good sand-clay road, and this should be effected as nearly as possible in the location of the highway. In the sandy stretches of our lowlands, we have but to dig a few feet at farthest to find a substratum of good clay to mix with the sand of the road bed. The ditches dug along the road side to obtain the clay serve the double purpose of draining the right of way and furnishing material for surfacing and should be dug with both these purposes in view. The mixture of the sand and clay should not be made haphazard, but just enough of the clay should be added to the sand to fill its pore space as determined for each section of the road. This can be readily determined by adding to a tumbler of the sand all the water it will absorb, measuring the water carefully as it is added.

Natural Sand-clay.—In many parts of the State a natural mixture of sand and clay exists in the proper proportions; but by *natural sand-clay* is usually meant a decomposed, partially disintegrated granite, of which we have an excellent supply at Chapel Hill. The value of the material depends upon the stage of decomposition attained, and defects may be remedied by the addition of sand or of clay according to the requirements of each case. This natural sand-clay does not make a good roadway for heavy traffic, but it cannot be surpassed for paths and sidewalks.

Lillington Gravel and Lilesville Gravel.—This consists of well rounded

quartz pebbles from the size of a pea to the size of a hen's egg, now extensively used in North Carolina in filters for municipal water supplies and in concrete construction, as well as in surfacing highways. Its best use is in filters, for angular stones serve better in concrete, and stone more angular in form and more basic in composition make a better roadway. Yet there are several stretches of damp, well-shaded roadway in North Carolina, where smaller pebbles have served well to make a good surface, being cemented together by an organic cement like much of the hard-pan or *alois* of The Landes of France and of portions of Florida.

Iron Sands and Ferruginous Hard-pan.—Throughout the sand-hills and coastal plain regions of North Carolina we find occasional beds of sand rich in grains of magnetic iron, and usually where these rest upon a bed of clay the sands or gravels with which they are mixed have become cemented together into an iron-stone affording excellent road-surfacing material. These magnetic sands are so abundant at several places on The Banks that they might even serve for iron ores if smelting facilities were at hand.

Nature has been generous to us with her supplies of road-surfacing materials. Let us make wise use of them.

NOTE—The speaker showed many jars and trays of the several materials from all parts of the State

Lignin Liquor as a Binder for Macadam, Gravel and Sandclay Roads.

BY GEORGE N. MOORE, OF PENNINGTON, NEW JERSEY.

It is generally recognized that macadam construction as a type, is fundamentally correct. But under a concentrated or greatly enlarged traffic, over that of the ordinary, it perhaps, will be conceded that the purely water-bound macadam road has ceased to always meet the tremendous strain of modern traffic.

Nevertheless, despite the broad knowledge of this form of construction had by road builders in general, the real origin of its heretofore entirely efficient bond, has not been generally understood.

Practically all of us thought it was a matter of mechanics and due entirely to the wedging of the stones, brought about in the early days by the compression of traffic, and later by the use of the roller.

That it was due mostly to chemical action was believed, or even thought of, by very few.

This is not surprising, because chemistry is a subtle thing and an understanding of the preferential liking of one atom for another rests mostly with the laboratory man.

As soon as road builders came to realize that plain water-bound macadam would not do, steps were immediately begun to remedy the evil, and, because the chemical theory was mostly hidden in the laboratory, such efforts were pursued entirely along mechanical lines, with the result that in some cases excellent roads were obtained, while in others, the reverse.

I suppose if these results had been uniformly satisfactory that would have ended the matter and it would have rested there for the time being, at least, although, fortunately, the Creator, in His wisdom, has endowed us with two faculties or traits that have made civilized man what he is, and that will, I believe, finally unlock the secret of the universe; they are discontent with things as they may be, and curious to see whether something better can be devised.

This lack of uniformity in results obtained from mechanical bonds set men to thinking, with the result that that chemist was called upon to find out just what it was that caused the cohesion of the macadam road, with the result that he proved beyond dispute that it was really due to chemical action.

He found that the soil water contained certain agents in the way of weak acids, that possessed the ability to dissolve in very small quantities, the silica contained in the stones, doing this as it trickled through the interstices and over the faces of the stones; and that when it dried out it left this deposit with which it was charged between the stones (much as a glass of water charged with salt would leave a deposit on the sides and bottom of the glass when the water has evaporated); and that this deposit so left between the stones constituted a very powerful bond that was insoluble in water, in fact, a union of the stones by a thin film of the stone itself.

In support of this he called attention to the glass that is found on the upper side of every leaf of every tree or plant. As is well known, this glass is in reality, a thin film of stone placed there for the purpose of water-proofing the leaf and preventing it from rotting; and that this stone or silica has been taken from the soil by the tree or plant, the weak acids in the sap of which (this sap being nothing more than soil water) have dissolved, carrying it up and spreading it over the leaf as it develops.

Things were now beginning to move along logical lines and action was governed by pure reasoning—the reasoning that prompts one to make the fire hotter if he wants more steam—with the result that search was made for some means by which the macadam could be strengthened by the production of more of the bond than was within the stone itself and that was not being leached out in sufficient quantities by the action of the soil water to cause the road to withstand the heavy traffic it was being called upon to bear.

The next step was the discovery that the lignin liquor, which is one of the products of paper-making, it being all there was in the tree excepting the wood fibre, contained in small quantities relative to a given bulk, the same weak acids contained in soil water and the sap of the living tree.

The next conclusion was, of course, that if this lignin liquor could be reduced and the acids produced in concentrated form the chemical action would be greatly accelerated and the desired results attained.

The problem had now resolved itself mainly into one of mechanics, but this was soon overcome, with the result that this liquor is now available in commercial quantities.

I have here a very striking illustration of the chemical action of lignin liquor. It is a piece out of a street at Covington, Virginia, and is composed of iron blast furnace slag mixed with about ten per cent of clay.

The lignin liquor has leached the silica out of the slag and so thoroughly mixed it through the clay that the clay has become stone-like and absolutely waterproof.

I have seen pieces similar to this, out of the same road, boiled in water for sixty hours without disintegration or even the slightest discoloration of the water, notwithstanding the presence of the clay.

The clay may be easily identified, especially by noticing the matrices or depressions that have been made in it at points where pieces of slag have rested.

The practice covering the use of lignin liquor is simplicity itself. It needs

no heating nor special apparatus. All that need be done is to place it in any ordinary watering cart, dilute it with more or less water, according to the density of the road, so that it may go down into it and get to work, and then sprinkle it over the surface as though it was plain water.

Lignin liquor is not noxious in any way and it will not injure anything that will stand contact with water.

This means that barriers need not be erected while the application is going on.

I think I should call your attention to the fact that roads treated with lignin liquor may be easily and quickly repaired, resulting in an indefinite prolongation of efficiency.

Sweep out the depression, sprinkle with the liquor, then cast in the road material, again sprinkle with the liquor, and then tamp into place. In a short time the patch cannot be detected from the rest of the road.

There is scarcely any road material on which lignin liquor cannot be used with success, excepting one composed entirely of sand, but where a combination of sand and clay is effected either artificially or naturally (say 80 per cent of sand and 20 per cent of clay), very good results are obtained.

Thomas F. Hickerson, Associate Professor of Civil Engineering, University of North Carolina, Chapel Hill, North Carolina, is authority for the statement in a recent issue of "Better Roads" that experiments in the use of the liquor indicate that sand-clay can be treated just as effectively as water-bound macadam in preventing dust and the destructive action of water on the road.

Professor Hickerson's opinion is probably based upon his observation of the tests made on a road at Chapel Hill by Doctor Pratt.

This road was composed of clay. An up-grade section was selected for the test. In the summer of a certain year (just what year it was I do not recollect, although I was present at the time) about 80 per cent of native sand was mixed with the clay, after which the road was sprinkled with lignin liquor.

The next time I saw this road was in the following winter, the day after a snow-fall had melted away, that winter having been an unusually hard one for this section, at which time, although the road was being subjected to much travel, there was no more ooze on it than would have been on a stone road under similar conditions, while further on, where sand had been mixed with the clay, but the road had not been treated with lignin liquor, it was cut up almost to a depth of a foot; still farther on, where it had neither mixed with sand nor treated with the liquor, it was in a most wretched condition.

Excellent results have been obtained from the use of this liquor on limestone; notably, for instance, on the Chicago road near Laporte, Indiana, and on the roadways around the old hotel at White Sulphur Springs in West Virginia. I have not visited the springs since the building of the new hotel was started and do not know what changes, if any, have been made in the road system there, but my reference is to driveways existing the last time I was there two years ago.

These two roads were old and contained before treatment about an inch of dust. Subjection to the action of the liquor caused this dust to become a part of the roads themselves, making them smooth, hard, and wear resisting. You will note that the dust was not first swept off, as would have been necessary before some binders could have been used. The significance of

this lies in the fact that by the retention of this dust and the making of it again a part of the road, just that much more was added to the life of the road.

The liquor has been found effective in the preservation of roads built of trap rock, and in this connection I think it will suffice to say that the main driveway through the White House grounds at Washington, D. C., is being maintained in pretty good shape by the use of it.

My remarks this morning on the chemical bond would not be complete without some slight reference to the splendid highways along the coast of New Jersey. They are built of clay-gravel, which is a very cheap form of construction, as that material is abundant in that section, and have been brought to a point by the use of lignin liquor where they are as good as any roads anywhere of any construction.

The most celebrated of these highways is probably the boulevard leading from Pleasantville across the Meadows to Atlantic City. It is sixty feet wide, five miles long, and as straight as a tight string. When I tell you that this highway sustains in an entirely satisfactory manner, a traffic amounting to between five and six thousand automobile movements each twenty-four hours during the summer season of about four months, I think you will agree with me when I say in the language of the day, that it is "some road."

It is also interesting to note that the chemical action of lignin liquor makes it possible to use for road building some materials that heretofore have been entirely unfit for such purposes—as, for instance, red shale, than which nothing could be more unsuitable. While this material is abundant and cheap over a wide area in northern New Jersey, it could not be used, because it soon ground up under traffic into a very sticky mud.

Laboratory experiments were carried on, resulting in the conclusion that shale could be made fit by the use of lignin liquor. This laboratory conclusion has been entirely borne out and shown to be correct by the construction of a shale road at Princeton University leading over to Graduate Hall, and then treating it with lignin liquor.

I do not think I err when I say this is the first worth-while shale road ever built in New Jersey. It is smooth, hard, and wear resisting, sheds water quickly, and gives promise of long continued efficiency.

The use of lignin liquor opens wide possibilities in the way of constructing cheap, yet satisfactory highways, by making available local materials not only of value, but that which has been heretofore without value; and my excuse for such constant reference to this liquor is that it is the only medium yet put forward in commercial quantities that will produce the chemical bond which I have endeavored to explain to you this morning.

I have not entered into the question of cost in connection with the use of lignin liquor, for the reason that to do so I would be obliged to make specific comparisons, which, of course, I should not do on this occasion; besides which it is, properly, a question for the manufacturer to answer.

I think, however, it would be within bounds for me to say that roads built with the aid of this material are the cheapest to construct and the cheapest to maintain.

I have gone into this subject in the briefest possible way this morning, but I trust I have created sufficient interest to cause you to look into it further, as I assure you it is entirely worthy of investigation.

There were submitted to the Institute for the consideration of its members, various blanks used by road engineers and superintendents, contract forms, etc. Some of these seem to be of especial interest and are given beyond:

**Form of Contract for Roads Used by Commissioners of Greene County,
Tennessee.**

Proposals for relocating, grading, improving and macadamizing roads in Greene County, Tennessee, as indicated and set forth in the plans and specifications for the work on file in the office of the Greene County Pike Commission, at Greeneville, Tennessee.....

Time and Place of Receiving Bids. Sealed bids or proposals for the above work will be received by the Pike Commissioners of the county of Greene at the office of their engineer in the town of Greeneville, Tenn., until 12 o'clock, noon, ... At which time and place the bids will be opened, read and compared and a contract may be awarded by the said Pike Commissioners to the lowest responsible bidder as soon thereafter as the said commissioners may elect. The right is reserved by said commission to reject any or all bids, if deemed for the best interest of the county.

Form.—Each proposal for the entire work must be accompanied by a certified check or approved bond for.....dollars, and each bid on any part or section by a check in the sum of.....dollars. The prices must be written in the bids and also stated in figures, and all proposals must be regarded as informal which do not contain bids for all items mentioned in the schedule.

Bids to be Verified.—Bidders are also required to state in their proposals their names and places of residence and the names of all persons interested with them in said proposal. The bid must be verified in writing by the person or persons making the same. If more than one person be interested, it is required that the verifications be made and subscribed to by each.

Award of Contract.—In case the contract shall be awarded to the person or persons making this proposal, he or they shall, within five days after receiving notice from the commission of such award, enter into a contract with the said commission for the performance of the work, as called for by the specifications hereto attached.

Bonds and Sureties.—The contractor shall execute a good and sufficient bond, for 10 per cent of the total estimated cost of the improvement, the same to be approved by the commission, the condition of the bond being that the contract shall be faithfully performed and that the contractors shall pay all sums agreed to be paid for the work done and materials furnished in performance of said contract. The bond shall be signed by the contractor as principal and two or more responsible residents of the State of Tennessee, ... as sureties, and such sureties, together, shall qualify in amount equal to double the penalty of the bond, over and above all other liabilities which they have incurred. The contractor shall also execute proper bond in such sum as the commission deems proper to pay and satisfy all sums due for material furnished and labor done upon said roads or in connection therewith. A responsible surety company doing business in the State of Tennessee will be acceptable to the commission.

Upon the execution of said bonds, the certified checks shall be returned to the parties bidding on the work. In case such lowest responsible bidder does not make the bonds required and enter into a contract, as above provided, then said certified check shall be forfeited as just and liquidated damages to the county. In case of failure of the lowest responsible bidder to enter into a contract within five days, as provided above, the commission shall have authority to either return the certified checks accompanying the other bids or it may notify the next lowest bidder that his bid will be accepted.

Definition of Engineer.—Whenever in the specifications and in this contract the word "Engineer" is used, it is to be considered as referring to the engineer appointed by the Commissioners of Greene County.

Definition of Contractor.—Whenever the word "Contractor" or words "party of the second part," or the pronoun in the place thereof, are used, they are to be considered as referring to the party or parties of the second part to this contract.

Stakes to be Preserved.—The contractor shall be responsible for the preservation of all stakes, streets or road bounds and bench marks made or established on the line of said work, and, in case they are lost or destroyed, he will be charged with the cost of replacing them.

Right to Change Grade or Plan, or Suspend Work.—The commissioners and engineer reserve the right to make any such and all such changes deemed by them, in their discretion, for the best interests of the county, including the right and power to change the character of the proposed work in material and construction, or otherwise, and to temporarily or permanently suspend or abandon any part of the same. Such suspension or abandonment shall be made only on written order of the commissioners or engineer to the contractor. The contractors agree not to claim damages by reason of delay caused by permanent injunctions or causes beyond human control, but may be granted a corresponding extension of time. But they shall give notice to the commissioners or engineer in writing at time of such delay of any purpose to claim extension of time.

Inspection.—All material and workmanship of any and every kind and description shall be subject to the inspection of the engineer or his assistants. Whenever unfaithful work is discovered, it shall be reconstructed immediately at the expense of the contractor on notice to that effect given by the engineer to the contractor or his agent in charge. And the determination of the engineer as to the unfitness of any material or work, shall be final and conclusive.

Work and Material to Agree With Specifications.—Any material furnished, which, in the opinion of the engineer, shall not be in accordance with these specifications, shall be immediately removed and other material furnished which shall be in accordance therewith and approved by the engineer.

Piling of Material. All material delivered on the street or road shall be neatly and compactly piled in such a manner to cause the least inconvenience to property owners and the general public; all private drives and street crossings shall be kept open. In case the commissioners and engineer order the work suspended, the contractor shall immediately collect and pile all material as specified in the preceding clause.

Obstructing Travel.—Travel on the street, road or any intersecting street or road shall be interfered with as little as possible, and said streets or

roads shall not be closed to travel for a greater period than twenty-four hours without the permission of the engineer. When necessary to do so, the contractor shall provide and set up signs at the nearest cross streets or roads upon each side of such part of the street or road obstructed. And when work is being done upon any traveled road, or whenever the work interferes with travel, suitable passing places will be provided, prepared and maintained by the contractors.

Injury to Property.—In the case of any injury to property by the contractor, which can not be entirely repaired by him, the said contractor shall pay to the owner all damages he or they may suffer thereby. He will, in all cases, be responsible for trespass or damages on the part of himself or employees.

Work to be Prosecuted at Certain Points.—The work shall be commenced at such points, and prosecuted in such a manner, as the engineer may from time to time direct.

The macadam or gravel on any road shall be commenced at the most distant point from the source of supply and hauling over unfinished work shall be restricted as much as possible. No macadam shall be placed on finished road bed until, in the opinion of the engineer, the grade is sufficiently settled to receive it properly, and the engineer may stop work on any given section, when, in his opinion, weather or other conditions are such as to prevent its being done satisfactorily.

Removal of Encumbrances and Rubbish.—All surplus material, of whatever nature, shall be removed from the line of work as the same progresses; any refuse or debris or other material not removed within ten days after the completion of the said work shall be removed by order of the engineer and the amount of the expense thereof shall be paid by the contractor or be deducted out of any money then due or becoming due said contractor.

Safeguards.—The said party of the second part shall be and is hereby required, during the performance of the said work, ... to place proper guards upon or around the same for prevention of accidents and at night will provide colored lights, if necessary, and shall indemnify, and save harmless the party of the first part, and Greene County, from all suits and actions of every kind and nature brought against it on account of negligence on the part of said contractor, or injuries received during the progress of the work.

The contractor shall take all risks from floods and casualties of every description. Notices given to the person highest in authority in charge on the immediate work shall be binding on the contractor.

Right to Close up Highways.—The right to close up any road and keep the public from using the same during the progress of the work is reserved by the commission. And when said roads are so closed or obstructed the contractor shall provide suitable passings as hereto stipulated.

When Upon Private Property.—The contractor, when at work upon those portions of the road running through private property, shall be governed entirely by provisions named in the deeds of right of way or as directed by the commissioners.

Only Competent Men to be Employed.—And the said part.... of the second part agree that..... will employ only competent, skillful and faithful men to do the work and that whenever the engineer shall inform in writing that any man on the work, in his opinion, is incompetent, unfaithful or is conducting any part of the work contrary to

instructions of said engineer, or his agents are, for any reason, unsatisfactory to the engineer, the contractor will immediately discharge him from the works and will not again employ him thereon.

Persons Designated to Have Access to Work.—The right to build bridges or culverts or lay any pipe or construct necessary appurtenances in connection therewith in said road at any time during the progress of the work is expressly reserved by the commissioners and engineers, as well as suspending the work or any part thereof, or at any time during the construction of the same for the purpose above stated without compensation to the contractor, and the said contractor shall not interfere with or place any impediment in the way of any person or persons who may be employed in the construction of the above stipulated work. The contractor shall, at all times, during the progress of the work, afford the engineer and assistants free and uninterrupted access to the work wherever the same is being prosecuted, and also afford such access to men, animals, wagons, tools and material in order that such agents, employees or contractors may be enabled, without hindrance or delay, to perform any work which, by the terms and conditions of this contract, may be required to be done.

Abandonment or Delay.—The said part..... of the second part further agree.....that if the work under this agreement should be abandoned by the part..... of the second part, or if at any time the engineer should be of the opinion and should so certify in writing that the said work, or any part thereof, is unnecessarily delayed, or that the said contractor is wilfully violating any of the conditions or covenants of this contract or executing the same in bad faith, the commissioners shall have the power to notify the aforesaid contractor to discontinue all work or any part thereof, under this contract, and thereupon said contractor agrees to and will discontinue such work, or any part thereof, and the said commissioners shall have the power to place such and so many persons thereupon to work at and complete the work or such part thereof in such way or manner herein described as they may deem advisable, acting with and under the directions of the engineer, and to use such material as they may find upon the line of said work, and to procure other material for the completion of same, and to charge the expense of said labor and material to the aforesaid contractor, and the expense so charged shall be deducted and paid by the party of the first part out of the money due or which may at any time thereafter become due to said contractor under and by virtue of this agreement or any part thereof, and if in any case such expense shall exceed the sum which would have been due if completed by said contractor, he shall pay the amount of such excess to the party of the first part on notice from the engineer of the excess so due, or be liable therefor upon his bond.

Claims for Work and Material.—The said part..... of the second part further agree that.....will punctually pay the workmen who shall be employed on the aforesaid road, and that.....will, upon the completion of the work, file with the commissioners an affidavit to the effect that all persons who did work or furnished material for the said part..... of the second part under this agreement, have been fully paid or provided for. Said affidavit shall further set forth that all claims for damages against said part..... of the second part or their agents, in the prosecution of the work aforesaid, have been fully paid, or secured. And shall give bond for such payment, as hereinbefore provided.

Not to Sublet.—And the said part.... of the second part further agree that..... will give..... personal attention constantly to the faithful prosecution of said work and that..... will not assign or sub-let the same without the consent of the part.... of the first part, but keep the same under..... control.

Contractors Using Materials.—The contractor shall get all material for use upon the road, of whatever kind or nature, from such location only as directed by the engineer and when at work on the improvements through private property he shall only use materials from off adjacent lands, when and where directed by the commissioners or engineer.

Commencement of the Work.—The part.... of the second part further agree that..... will begin the aforesaid work within..... days after the execution of this contract, at such place or places as the engineer and commissioners may designate and progress therewith from said place or places so as to complete the same in accordance with this agreement on or before the..... day of.....

Engineer's Estimate.—The said part.... of the second part further agree that the return or report of the engineer in charge of the work shall be the account by which the amount of the materials furnished and work done shall be computed.

Engineer's Certificate.—The certificate of the engineer in charge, that the work has been faithfully performed in accordance with the requirements of this contract and the specifications herein contained, shall be a condition precedent to the right of the said part.... of the second part to receive payment due..... under this agreement for the work or any part thereof.

Monthly Payments.—Monthly payments, if desired, shall be made upon the proper certificate from the engineer in charge to the extent of 90 per cent of the value of the work done at the time, as estimated by the engineer. Payments to be made on the fifteenth (15) of each calendar month for the work done and material furnished during the previous month.

Certificate of Completion.—Upon the completion of the work embraced in this agreement the engineer shall file with the commissioners a certificate stating the fact of the proper completion of the contract.

Final Payment.—The contractor shall satisfy the commissioners by proper receipts from all parties furnishing material and performing labor, that the same has been fully paid or provided for before he shall be entitled to receive the contract price in full. And the party of the first part hereby agrees, upon completion of the work, and receipt of the engineer's certificate, to pay the said part.... of the second part the balance then due said contractor. But this right to the reserved per cent shall only accrue when the entire contract of the second party is complete; and not upon the completion of each road, or distinct part of the work.

Extra Work.—It is expressly understood that the said part.... of the second part shall not receive payment for any extra work of any kind or nature, unless the same shall be ordered by the chief engineer in writing; and the claim therefor presented at the first monthly payment thereafter, and no work will be deemed extra that is capable of being measured, computed or estimated under these specifications.

Interpretation of Specifications.—In case of ambiguity of expression in the specifications, or doubt as to the correct interpretation of the same, the

matter shall be submitted to the chief engineer, whose decision shall be final and binding on both parties.

GENERAL SPECIFICATIONS.

Clearing and Grubbing.—The whole of the right of way or ground acquired or set apart for the road shall be cleared of all trees, brush or other perishable matter which shall be burned or removed from the entire face of the ground to be occupied or set apart for the right of way in such a manner as not to damage adjoining lands, crops or fences or disturb the engineer's stakes. But if there be any timber on the right of way of merchantable quality it shall not be burned or destroyed but cut in such lengths as may be designated by the engineer and placed in a convenient place for removal by the commissioners or their agents without extra compensation, it being a part of the work of clearing.

Trees, saplings and brush shall be cut close to the ground. All stumps shall be grubbed from slopes, of cuts, from ditches, from new channels for waterways and elsewhere on the right of way, if required.

Clearing and grubbing shall, in all cases, be kept 500 feet ahead of grading, and a separate price shall be fixed for each, per acre actually cleared or grubbed. No payment shall be made for removing grass, weeds, briars, small bushes, fences or growing crops from the right of way or road bed.

Where no estimate is made of clearing and grubbing in the engineer's approximate, the prices bid for excavation must include all clearing and grubbing and no bid will be considered on such section or road.

GRADING.

Grading.—Under this general head will be included excavations and embankments required for the formation of the road bed, or in any way connected with, or incident to the construction or drainage of the same, or the change or crossing of roads and streams.

All grading shall be done and estimated by the cubic yard, measured in excavation and paid for as excavation only.

The road will be graded with such widths, depths and slopes of cutting and filling as the engineer may determine; and such ditches shall be dug within or without the limits of the road as directed.

Excavation.—The road bed shall be of such width and cross section as the engineer may direct from time to time, as the work progresses.

All excavation and grading must be done in strict accordance with the line and grade stakes; all crests shall be neatly finished, and slopes shall be true and straight and of such inclination as may be indicated from time to time by the engineer.

The road bed shall be surfaced smoothly to conform to grade stakes, and side ditches shall be excavated to the depth and cross section indicated by the engineer. Excavation for ditches, for change of channels of streams, for change of roads or approaches, for foundation for masonry, and excavation of any kind which may be required for the construction of the road, shall be done well and in conformity with the grades, locations and cross sections which may thereafter be determined and fixed by the engineer.

All material that may slide from the sides of cutting, if the slides are attributable, in the opinion of the engineer, to the carelessness or negligence

of the contractor, shall be removed by the contractor at his own cost, to such place as the engineer may direct.

All excavations shall be done and estimated by the cubic yard, measured in excavation and paid for as excavation only.

Material excavated from without the slope line shall be at contractor's loss.

Excavation shall be classed under the following heads, viz.: Earth, Loose Rock, and Solid Rock.

Earth shall include loam, clay, sand, chert, cemented sand, indurated clay, joint clay, pipe clay, decomposed rock and shale, and all other material of an earthy kind. Earth shall also include loose stone or boulders which do not exceed two (2) cubic feet in size, inclosed in masses of earth wherein the proportions of boulders or loose stone is one-half ($\frac{1}{2}$) or less.

Loose Rock shall include hard shale, slate, soft friable sandstone, cemented gravel, or conglomerated rock, stratified stone in layers of six (6) inches or less, masses of boulders or detached rocks, free from earth in which the average size of boulders or detached rocks is not less than one (1) cubic foot, nor more than one (1) cubic yard; masses of earth mixed with loose stone and boulders of one (1) cubic foot or more average size, wherein the proportion of rock to the whole mass is more than one-half ($\frac{1}{2}$).

Solid Rock will include all rock in place, which rings under the hammer in masses of more than one (1) cubic yard with the exception of stratified stone described in the specification for loose rock.

Rock Cuts shall be excavated below grade, and afterwards filled to grade with small stone or such other material as the engineer may designate and payment shall be made for excavation to a depth of one-half ($\frac{1}{2}$) foot below grade, but no payment shall be made for refilling to grade.

Haul.—All material from excavations, except when otherwise directed by the engineer, shall be deposited in the embankments. The cost of hauling and depositing or placing excavated materials in embankments, when the average haul is not more than five hundred (500) feet, shall be considered as paid for in the price paid for excavation.

Extra haul of one cent (1) per cubic yard shall be estimated and paid for as follows: Whenever material from any cut is necessarily hauled a greater distance than five hundred (500) feet, there shall be paid in addition to the price of excavation the price of extra haul per one hundred (100) feet for each one hundred (100) of average haul in excess of an average haul of five hundred (500) feet. Fractional parts of one hundred (100) feet of extra haul shall be paid for at a proportional rate.

Average haul shall be computed for each cut separately, and short haul from one cut shall not offset long haul from another cut. The average haul from one cut shall be the distance between the center of gravity of that portion of the cut hauled and center of gravity of the fill which the material hauled from that cut makes.

Drain Pipe.—Where bids are called for on pipe for waterways hauled and laid complete, it is to be understood the commissioners are to furnish f. o. b. cars at most convenient point to work, the contractors to unload the same in a careful and prudent manner at place to be furnished by the commissioners.

Where bids are called for on pipe for waterways furnished and laid complete, it is to be understood that all pipe so furnished by the contractor is subject to inspection by the engineer and must be of an approved quality.

Masonry.—All masonry will be estimated and paid for by the cubic yard and will be included under the following heads, viz.: *Second Class Masonry, Third Class Masonry, Box Culvert Masonry, Rip-Rap, Paving, Concrete Masonry.*

Second Class Masonry will be rock-ranged work of the best description to be laid in cement mortar as the engineer may direct, the stone to be of the best and hardest quality which, in the judgment of the engineer, will not disintegrate or split from exposure to the weather. All face stone shall be accurately cut and lined and laid in courses not less than twelve (12) inches thick, and decreasing from bottom to top of the walls, the joints to be well broken—no break to be less than nine (9) inches. No joint to be laid more than three-fourths ($\frac{3}{4}$) of an inch. All stretchers shall have at least as much bed as rise and shall hold the face size at least nine inches back into the wall on both upper and lower beds. All headers shall have at least twice as much bed as rise and shall hold the face size at least two feet back into the wall. Headers shall occupy at least one-fourth of the wall. No header shall show on the face less size than the thickness of the course in which it is laid. All backing shall be laid with the largest stone practicable and thoroughly grouted. The backing stone shall always be cut down to the level of the course before it is set. No spawls shall be used as levelers.

Third Class Masonry will be of the best description of uncoursed masonry to be laid in cement as the engineer may direct; to be built of stones not less than eight inches thick, to have horizontal beds and vertical joints on the face. Vertical joints of the face to be not less than eight (8) inches from the face, and as much more as the stone will work. No joint to be laid more than three-fourths ($\frac{3}{4}$) of an inch. The stretchers and headers to be not less than two (2) feet long; to have beds not less than fifteen (15) inches wide and always at least as wide as high. At least one-fourth of the whole number of stones in the face of the wall to be headers and arranged so as to distribute them as equally as practicable over the whole face. The headers shall run through the wall, or interlock, or be connected in the heart of it. The backing stones shall be of similar general dimensions and proportions as the face stones with equally good beds and bond. No spawls shall be used as levelers.

Box Culvert Masonry will be laid in cement mortar. The side walls shall be built of good-sized and well shaped stones properly laid and bound together in each course by stones extending entirely through the wall, at least every six feet in length of the wall. Headers and stretchers shall not be less than fifteen (15) inches wide and at least as wide as high. The back of walls to be built the same as the front, with the exception of the facing. The upper course to have at least one-half ($\frac{1}{2}$) of the stone headers and its stretchers in no case less than fifteen (15) inches wide; no stone in this course to be laid less than six (6) inches thick. The covering stones to be sound and strong and of such shapes as to form suitable joints; to be approved thickness according to width of opening, but in no case less than eight (8) inches thick and to lie with their whole width not less than twelve (12) inches on each side wall. Care will be taken to show a neat finish at the ends of the culvert.

Rip-Rap shall consist of stone placed as the engineer may direct for the protection of masonry or earthwork.

Paving shall be made by setting stones from eight (8) to twelve (12) inches in depth on edge breaking joints as directed by the engineer.

General.—The ends of the pipe shall be protected in such manner as may be directed by the engineer.

The hammering or dressing of stones upon a wall where cement is being used is expressly forbidden; and the stones must be lowered into place so as to not disturb those previously laid.

All stones for different classes of masonry must be furnished from the best quarries in the community where the work is done.

All masonry to be estimated and paid for by the cubic yard; and the number of cubic yards to be paid for shall be the actual solidity thereof, by strict mathematical calculation—any vacant space or spaces that may have been left therein in accordance with the plans and specifications of the work and requirements of the engineer being excluded; and no double measurement of any part or parts of said masonry being allowed, any rule or custom as to the mode of measurements to the contrary notwithstanding.

The price per cubic yard of masonry will include the cost of furnishing all materials; it will also include the cost of foundations, pumping, bailing, scaffolding and all other expenses necessary to the construction and the completion of the masonry according to the plans, in all cases in which it is not provided by these specifications that it shall be otherwise; and the contractor shall be at all risks from water and casualties.

Cement mortar in all classes of masonry must be made of one part of good Portland cement and two parts of clean, sharp sand, well mixed together with clean water, in clean mortar beds constructed of boards, and must be used immediately after being mixed.

Sand for mortar must be washed if not clean enough to be used otherwise.

All classes of masonry laid in cement must be neatly pointed with cement mortar finely tempered.

The foundation courses for all classes of masonry must be large selected stones.

No masonry of any kind will be covered up before being accepted by the engineer.

Foundations for masonry shall be excavated to such depth as to secure a safe and solid foundation of which the engineer shall judge; the materials excavated to be measured, classified and paid for at the rates provided for like materials in grading.

When a safe and solid foundation can not be procured at a reasonable depth, there shall be prepared by the contractor such artificial foundation of timber, piling, crib work or concrete, or either in combination with concrete, as the engineer may direct.

Timber used in foundations, bridges or otherwise, shall be sound white oak, or such other suitable timber as the engineer may approve. It will be paid for per thousand feet board measure, the price to cover material, framing and putting in place. The engineer shall determine the size, shape, manner of framing and placing all timber used in foundations.

Concrete.—Concrete must be composed of one part of best quality Portland cement, approved by the engineer, two and one-half parts of clean, sharp sand, and five parts of clean, sound, durable limestone, dust removed, or other sound stone acceptable to the engineer, and so broken as to pass through a two inch ring.

Concrete shall be mixed in a batch mixer of approved design, or if in small quantity may be mixed by hand in a manner to be decided by the engineer.

At all times the mixing and placing of concrete shall be under the direction of a competent inspector and shall be placed in a careful and workmanlike manner.

The necessary forms for concrete shall be furnished by the contractor, prices for concrete to include cost of same, and where surfaces are exposed the lumber to be used shall be dressed and jointed and the surface of the concrete shall present a neat and smooth surface when forms are removed, no forms to be removed from concrete until, in the opinion of the engineer, it has become sufficiently hardened. Reinforcement of iron shall be used where required by the engineer, in such manner as he may direct.

Location of Drains.—In locations where but a small quantity of water passes, drain pipe may be substituted for culverts as may be directed by the engineer.

Specifications for Macadamizing.—The work to be done under this specification will consist in laying a finished roadway in accordance with plans and specifications. The width of the macadam on all roads shall hereafter be determined by the Pike Commissioners or the engineer, and they shall have the right to change the width and depth at their option.

Where bids are called for, macadam or gravel by the cubic yard, it is understood that the broken stone or gravel shall be delivered in carts or wagons holding one (1) cubic yard or multiples thereof, measurements and accounting for same shall be at the point of spreading, the price to include, preparing the subgrade, shouldering same, quarrying stone, crushing, loading, hauling, spreading, watering and rolling same.

Sub-Foundation.—When the excavation and embankments have been brought to a proper depth below the intended surface of the roadway, the cross section thereof conforming in every respect to the cross section of the road when finished, the same shall be rolled with a ten ton roller until the surface is thoroughly compacted. If any depressions form under such rolling, owing to improper material or vegetable matter, the same shall be removed and good earth substituted, and the whole re-rolled until thoroughly solid and to grade. Whenever, in the opinion of the engineer, the sub-grade is in proper shape to receive the macadam, the contractor will be required to maintain at his own expense until the macadam is put on; on all roads which have been graded by former commissioners the contractor will be paid for dressing and re-surfacing as directed by the commissioners and engineer.

Banking.—Contractors shall procure dirt for banking from ditches and cuts, but not from embankment, and place same outside and against boards flush with top of loose stone and gradually sloping towards ditches as directed by engineer.

First Course of Broken Stone.—After the road bed has been formed and rolled, as above specified, and has passed the inspection of the engineer, the first layer of broken stone, consisting of stone ranging from three (3) inches to one and one-half ($1\frac{1}{2}$) inches in size, shall be deposited in a uniform layer and rolled repeatedly with ten ton roller until compacted to the satisfaction of the engineer, beginning at the edges and working towards the center.

The depth of loose stone in this and all other courses should be measured by blocks the required thickness of the said loose stones.

These blocks must be placed at frequent intervals amid the loose stone when being spread. The compacted stone in this course must be four (4) inches in thickness, or of such thickness as the engineer may direct.

If the stone in this lower course creeps ahead of the roller, and will not compact properly, the stone shall be sprinkled ahead of the roller or a small quantity of stone screenings, or earth, be placed over the surfaces until the stones cease to sink or creep in front of the roller, and is, in the judgment of the engineer, hard, firm and compact.

Second Course of Broken Stone.—The second course of broken stone shall consist of two (2) inches, after compacting, of a stone ranging from three-fourths ($\frac{3}{4}$) inch to one and one-half ($1\frac{1}{2}$) inch. This course shall be spread in a uniform layer in depth and rolled until thoroughly settled in place. Water may be applied ahead of the roller in this course.

Surface.—When the two courses are rolled to the satisfaction of the engineer, stone screenings ranging from three-fourths ($\frac{3}{4}$) inch to dust, or otherwise if directed by the engineer, shall be applied in a thin coat over the surface of the road and shall then be thoroughly wet with a street sprinkler ahead of the roller with the object in view of flushing as much as possible of the screenings into the interstices of the second course, the operation being repeated, more screenings being added, wet down and rolled until the water stands on the surface instead of penetrating, and the screenings entirely cover the second course of stone.

The contractor will be required to use such screens as, in the opinion of the engineer, will give most satisfactory results.

Gutters and ditches shall be constructed on the lines and to the depth and width indicated by the engineer, and the same to be paid for as excavations at the price per cubic yard named in contract. They shall be constructed in a practical manner as directed by the engineer. The ditches shall be excavated to the special width and depth and to the slope as required.

Ditches shall be shaped and cleaned up, all excess material be removed, and the shoulders rolled hard and firm and level with the surface of the roadway, after the broken stone has been completely rolled in place.

The road surface and ditches shall be maintained by the contractor until the whole road shall have been accepted.

SPECIFICATIONS FOR GRAVEL ROAD.

Sub-Foundation.—Sub-foundation shall be prepared in the identical manner specified for broken stone macadam.

Shouldering.—Shouldering is to be provided as specified for broken stone macadam. These shoulders should be at least six (6) inches high to retain the material while it is being placed.

General.—The engineer may stop any portion of the work if, in his opinion, the weather is such as to prevent the work being done in a satisfactory manner.

The contractor is expressly forbidden from putting down macadam or gravel while road bed is too soft from rain or other causes, and the commissioners or their representatives shall always be the judge of this.

The water used by the contractor for sprinkling shall be secured and put on the road at his own expense, the engineer to be the judge of the time, manner and amount of sprinkling. No macadam shall be put down during extreme cold or freezing weather.

The commissioners will furnish an inspector to receive, measure and give a ticket for each cubic yard of crushed stone or gravel delivered at the place of spreading, said tickets to be paid monthly at contract price. The measurements of all crushed stone or gravel shall be at place of spreading.

When received by the engineer, surface ditches shall be cut on top of the slope of excavation and at foot of the slope of such dimension and grades as he may direct, same to be paid for as excavation.

Where it becomes necessary to create borrow pits, same must be staked out by the engineer previous to opening same. Care must be taken to keep such borrow pits a uniform and regular size admitting of proper measurements.

All materials used for the construction of road, whether dirt, stone or gravel, shall be taken from such location as directed by the commissioners or engineer.

Stone for Repair.—Crushed stone shall be delivered at any point designated by the engineer, and dumped along, by or near the road bed for repairing purposes.

Time Allowed for Completion.—The time allowed the contractors in which to complete the entire work on this section will be.....months from the signing of this contract.

Strict Adherence to the Specifications.—Bidders are informed that the engineer will allow no deviations from the specifications, except upon his written order.

The contractors will be required to complete the whole work to the satisfaction of the commissioners, and the engineer, and in accordance with the plans and specifications hereto annexed.

Plans, profiles and specifications may be examined and further information obtained at the engineer's office.

Form of Contract Used by Orange County Good Roads Commission.

ORANGE COUNTY GOOD ROADS COMMISSION.

HIGHWAY IMPROVEMENT.

INSTRUCTIONS TO BIDDERS, CONTRACT, AND SPECIFICATIONS.

CONTRACT AND SPECIFICATIONS.

For Clearing and Grubbing, and Grading, the.....
Sections of the County Road Between.....
and....., Orange County, North Carolina.

INFORMATION TO BIDDERS.

1. Bids shall be enclosed in plain envelope marked in upper left-hand corner "Sealed Bid," and bearing the following address:

S. Strudwick, Chmn. Orange County Good Roads Commission, Hillsboro, North Carolina.

2. The bids must be signed by the individual members of a firm or company making bids and bear also the legal signature of the firm or company.

3. Prices must be given in both writing and figures, and in the order in which they appear in the list of estimated quantities.

4. Bids must be accompanied by a certified check to the amount of one hundred (\$100) dollars for each section or portion thereof on which the bid

is made. This check is to be made payable to the Orange County Good Roads Commission and is to be returned to the bidder if he properly executes this contract within fifteen (15) days after notice by the Commission of the acceptance of his bid. If the bidder fail to execute this contract within fifteen days after such notice then this check shall become the property of the Orange County Good Roads Commission absolutely.

5. Before the contract is awarded the bidder shall furnish satisfactory bond in a surety company approved by the Commission in the sum of fifty (50) per cent of the amount of the bid for the faithful performance of the work, and for its completion within the time agreed upon.

6. The Commission reserves the right to reject any and all bids and to re-advertise for bids or to have the work done by the county forces.

7. The work is divided into sections of six thousand (6,000) feet each, beginning and numbered consecutively 1, 2, 3, etc.

8. Separate bids must be made for each section; but single bids for sections will be received, provided they are accompanied by separate bids for each section.

9. Separate bids must be made for each of the following classes of work: 1. Clearing and Grubbing; 2. Grading; 3. Draining. Single bids for all three classes will be received, provided they are accompanied by separate bids for each class.

10. The estimated quantities given herewith are approximate only and are given as the basis upon which all bids are to be compared.

11. Copies of the plans and profiles, etc., may be seen at the office of S. Strudwick, Chmn., Hillsboro, N. C., or at the office of M. H. Stacy, Sec., Chapel Hill, N. C.

ESTIMATED QUANTITIES.

Section No.....

<i>Clearing.</i>		Price Bid.
Light (average of fewer than five trees one ft. in diameter to the hundred lin. ft. of right of way).....	acres,	.....
Heavy (average of more than five trees over one ft. in diameter to the hundred lin. ft. of right of way).....	acres,	.....
<i>Excavation.</i>		
Earth	cu. yds.	.....
Loose Rock .....	" "	.....
Ledge Rock .....	" "	.....
Borrowed Material .....	" "	.....
Overhaul	yd. ft.	.....
<i>Concrete.</i>		
Foundations	cu. yds.	.....
Headwalls .....	" "	.....
Small Culverts .....	" "	.....
Reinforced .....	" "	.....
<i>Vitrified Pipe.</i>		
12-inch	lin. ft.	.....
15-inch .....	" "	.....
18-inch .....	" "	.....
24-inch .....	" "	.....

Corrugated Iron Pipe.

12-inch	lin.	ft.	.....
16-inch .....	"	"	.....
20-inch .....	"	"	.....
24-inch .....	"	"	.....
30-inch .....	"	"	.....
36-inch .....	"	"	.....
42-inch .....	"	"	.....
48-inch .....	"	"	.....

Rubble Masonry.

Foundations and Paving.....	cu.	yds.	.....
Headwalls .....	"	"	.....
Culverts .....	"	"	.....
.....			
.....			
.....			
.....			

CONTRACT.

STATE OF NORTH CAROLINA,
COUNTY OF ORANGE.

This contract for Clearing and Grubbing, Grading, Draining the..... sections of the county road between.....and..... in Orange County, made and concluded this the....day of....., 19...., between the Good Roads Commission of Orange County, party of the first part, and operating under the name of..... party of the second part.

Witnesseth: That in consideration of the sums hereinafter mentioned to be paid by the party of the first part, and the penalty expressed in the bond of even date with this contract and annexed hereto, the party of the second part hereby agrees with the party of the first part, at their own proper expense, to do all the work and furnish all the material necessary to clear and grub, grade, and drain the.....sections of the county road between..... and....., in Orange County, in accordance with the plans and specifications attached hereto, and signed by the Chairman and Secretary of the Commission and the Highway Superintendent, with such detailed directions and drawings as may be given by the Engineer during construction, and in full compliance with the terms of this contract.

Plans, Profiles, and Specifications.—The plans, profiles, and specifications are hereby made a part of this contract, and will be held to cover any and all work that can reasonably be understood to be required for a complete and workmanlike job. It is understood that no advantage will be taken of any discrepancy that may occur in the drawings or any ambiguity that may exist in the specifications.

Disputes.—If any doubt or dispute arise as to the proper interpretation of the plans, specifications, or contract the complaint shall be made to the Engineer in writing and shall be decided by him.

Changes in Plan.—The right is reserved to make any changes in alignment, grade, or cross sections that may seem advisable to the Engineer, provided

that payment to the Contractors shall be increased or diminished in proportion as the amount of labor is increased or diminished. In case additional material is required by the change it shall be paid for at the price made in the bid.

Contractor's Liability.—The Contractors shall be responsible for all risks, accidents and damages to persons or property that may occur during prosecution of the work by reason of negligence or carelessness on the part of the Contractors, their agents, or employees.

Subletting Contracts.—The Contractors agree to give their personal attention to the work embraced by this contract, and not to sublet the same, or any portion of it, without the written consent of the Commission. In case subletting is permitted the parties of the second part, herein named, shall be held fully responsible for the satisfactory completion of the work.

Instruction to Foreman.—The superintendents or foremen of any particular portion of the work shall receive and obey instructions from the Engineer in case the Contractors are not themselves present.

Beginning and Completion of the Work.—This work is to be begun within days after the execution of this contract, and is to be diligently pushed to completion in such order as may be prescribed by the Commission.

The Contractors hereby agree to complete the work on or before....., and should they fail to complete the work on said date, then they shall forfeit the sum of ten (\$10) dollars on each section unfinished for each and every day thereafter until the work is completed.

The Commission hereby agrees to close to traffic the sections upon which work is being done if requested to do so by the Contractors.

Bond for Performance of Work.—Before this contract is executed the Contractors shall furnish bond in the sum of fifty (50) per cent of the amount of their bid for the faithful and diligent performance of the contract and for the completion of the work in accordance with the above conditions. This bond must be in a reliable Surety Company and must meet the approval of the commission.

Removal of Rejected Work.—The Contractors shall immediately remove and reconstruct, at their own expense, all work not done in accordance with this contract, and failure of the Engineer to disapprove of any work at or before the monthly estimate, or any time before the final completion and acceptance of the entire work, shall not constitute an acceptance, notwithstanding the materials and work may have been estimated and paid for.

Abrogation of Contract.—The following causes shall, at the option of the Commission, constitute an abrogation of this contract: 1. Failure on part of the Contractors to perform the work according to the terms of the contract; 2. Abandonment of work for more than fifteen (15) days continuously unless prevented by an act of Providence.

Completion of Work in Case of Default.—If the Contractors abandon the work or otherwise default in the performance thereof the Commission shall have the work completed by such other means as it sees fit, and the total cost of completion shall be borne by the defaulting Contractors.

In case the Contractors default in the performance of the work, no equipment nor material belonging to them and situated on the work shall be removed without the written consent of the Commission. Such material and equipment shall, if required by the Commission, be used in completing the work.

Laws and Ordinances.—The Contractors and their agents shall so conduct the work as to fulfill all the requirements of State, county, and town laws and ordinances that apply to the work, and shall take all reasonable precautions to guard against accident and loss of life.

Incompetent and Disorderly Persons.—Should any person employed by the Contractors show evidence of incompetence or behave disorderly he shall be immediately discharged on request from the Engineer, and shall not be again employed on the work without the consent of the Engineer.

Definitions.—Where the word "Commission" is used in this contract it shall be understood to mean the Good Roads Commission of Orange County, party of the first part to this contract, or their authorized representatives limited to the particular duties entrusted to them.

Where the word "Contractors" is used it shall be understood to mean parties of the second part to this contract, or their authorized representatives.

Where the word "Engineer" is used it shall be understood to mean the Highway Superintendent of Orange County, or his authorized representative limited to the particular duties detailed to him.

Where the words "satisfactory to," "as ordered," "as permitted," "accepted," etc., they shall be understood to mean satisfactory to, as ordered by, as permitted by, accepted by, the Commission or its authorized representative.

Payments.—Payments shall be made by the Commission to the Contractors as follows:

On monthly estimates furnished by the Engineer, ninety (90) per cent due on said estimates; ten per cent to be retained until a section is completed, when the whole amount due on that section will be paid on certificate from the Engineer that the work on that section has been completed in accordance with the specifications and contract. All partial estimates and partial payments shall be corrected in the final estimate and final payment.

In accordance with the foregoing, the Orange County Good Roads Commissioners, party of the first part, agrees to pay....., party of the second part, for work done, at the rates and prices set forth by the party of the second part in the lists of estimated quantities under the heading "Price Bid."

Section	Clearing and Grubbing.	Grading.	Draining.
1 . . .	\$.....	\$.....	\$.....
2 . . .	\$.....	\$.....	\$.....
3 . . .	\$.....	\$.....	\$.....
4 . . .	\$.....	\$.....	\$.....
5 . . .	\$.....	\$.....	\$.....
6 . . .	\$.....	\$.....	\$.....
7 . . .	\$.....	\$.....	\$.....
8 . . .	\$.....	\$.....	\$.....
9 . . .	\$.....	\$.....	\$.....
10 . . .	\$.....	\$.....	\$.....
11 . . .	\$.....	\$.....	\$.....
12 . . .	\$.....	\$.....	\$.....
Total . . .	\$.....	\$.....	\$.....

Contract to be Read and Understood.—The Contractors hereby agree that they have read every clause in the contract and have examined the plans, profiles, and specifications, and that they understand the same and will comply with all the terms thereof.

This contract is to be executed in triplicate, one copy to be retained by the Commission, one furnished the Contractors, and one to the Engineer.

Further Agreements.

.....

In witness whereof, we, the parties to these presents, have hereunto set our hands and seals, this the day and year first above written.

.....

Good Roads Commission of Orange County.

.....

Contractors.

Signed in the presence of:

.....

SPECIFICATIONS.

Work to be Done.—The Contractors are to furnish all equipment, labor, and material required for the clearing, grubbing, draining and grading of the road above designated in accordance with the accompanying plans and specifications under the inspection and jurisdiction of the Engineer. Said plans and specifications are to be signed by the Chairman and the Secretary of the Good Roads Commission and by the Highway Engineer.

The Contractors are to leave the road and the immediate vicinity in a neat, presentable condition and ready for surfacing.

Clearing and Grubbing.—The right of way shall be cleared to a width of twenty (20) feet on each side of the center line, unless otherwise specified by the Engineer; all trees, bushes and brush within the space designated to be cut down and removed to the adjoining land and the brush burned, as the Engineer may direct.

Within the space included by the slope stakes all roots, stumps and timbers imbedded in the ground shall be grubbed out or removed by a stump-puller, except where they will be covered by a fill two and one-half feet or more in height, in which case they may be cut off at the surface of the ground

All other timber on the right of way shall be cut close to the ground or pulled or grubbed.

Earthwork.—The roadbed shall be graded to the grades, widths, and shapes shown by the accompanying plans, profiles, and cross sections, which are a part of these specifications.

Excavation.—Under the head of excavation shall be included all excavation required for the formation of the roadbed, cutting drainage ditches, cutting new channels for streams, cutting all necessary approaches for intersecting roads, and all excavation necessary to the proper construction of the road, including the hauling and depositing of the material in embankments wherever required by the Engineer, excepting that all material required to be hauled more than six hundred (600) feet shall be classed as overhaul and shall be paid for according to contract.

All grading shall be done and paid for by the cubic yard measured in excavation unless a bid be accepted for a certain amount per mile, in which case there will be no extra charge for overhaul nor for borrowed material.

No material shall be borrowed except when the amount excavated from the roadbed in one thousand (1,000) feet in each direction from the place of deposit is insufficient to make the required embankment, unless it is specially authorized by the Engineer. Nor will payment be made for borrowed material if an equivalent amount be wasted within one thousand (1,000) feet on either side of the place of deposit, unless the material wasted is unfit for use in the embankment and is ordered wasted.

Borrow Pits.—Where borrow pits are necessary they shall be staked off by the Engineer, and on completion shall be dressed up to a uniform surface and grade so as to drain off the water.

Classification of Material.—All excavation shall be classed under the following heads: 1. Earth; 2. Loose Rock; 3. Ledge Rock.

Earth shall include all material that can reasonably be plowed and that does not come under the classification of loose rock.

Loose Rock shall include all stone found in separate pieces containing more than one cubic foot and less than six cubic feet, and all shale and slate loose enough to be removed without blasting.

Ledge Rock shall include all rock and boulders over six cubic feet in volume which requires blasting for its removal.

No unsightly piles of rock or rubbish of any sort shall be left within the right of way by the Contractors when they have finished.

Embankments.—Embankments shall be formed of earth, gravel, or rock. They shall not contain loose vegetable matter nor refuse matter of any kind. When sod is placed in embankments it shall be placed near the edges and at least two feet below the finished surface, otherwise it shall be wasted.

Embankments shall be formed in layers approximately one foot in depth, and the material shall be spread as dumped by allowing the scrapers to turn over gradually instead of dumping in heaps.

When an embankment is formed of rock the rock shall be carefully placed and the spaces filled with earth or gravel.

Drainage.—Under the head of drainage is included all tile drains necessary for draining the subgrade, all cross-over drains of whatever character, all waterways that shall be classed by the Engineer as culverts, whether of pipe, concrete, stone, or steel and concrete, and all paving of waterways and channels leading to and from the same.

Where required by the Engineer, catch basins shall be constructed at the entrance to culverts, and the outlets shall be paved or otherwise protected from undermining, as the Engineer may direct.

Culverts.—Culverts shall be built of one of the following materials: 1. Stone; 2. Vitrified pipe; 3. Corrugated pure iron pipe; 4. Concrete. Their location, length, area of waterway, and type shall be as directed by the Engineer.

Stone.—The use of rubble masonry will be allowed for culverts up to spans of four feet. The bottom shall be paved with stone to a depth of not less than ten inches, and the arch shall have a thickness of at least one foot. The stone shall be laid in good cement mortar of the proportions 1:2½.

Vitrified Pipe will be allowed for culverts only when the earth covering will be two or more feet. The pipe shall be of good quality, well burned and free from cracks, and shall have well-formed bells.

The pipe shall be laid to a uniform grade of not less than one-fourth inch to the foot. Both inlet and outlet ends shall be protected by headwalls of concrete or stone laid in cement mortar of proportions 1:2½. The backfilling shall be carefully tamped in and no rocks will be allowed to touch the pipe.

Corrugated Iron.—Where corrugated iron is used for culverts it shall be of a quality and gauge satisfactory to the Engineer. The specifications as to alignment, grade, headwalls, and manner of laying are the same as for vitrified pipe.

Concrete.—Concrete for culverts shall be composed of a good grade of Portland cement, which will meet the specifications for same, hereinafter given, clean, sharp sand, and crushed stone or gravel in the proportions 1:2½:5 for small culverts, 1:2:4 for reinforced culverts, and 1:3:6 for foundations.

The concrete shall be thoroughly mixed and spaded into the forms, the coarse material being pressed away from the forms to allow a smooth surface of the finer material to be formed. The culverts shall be built to the dimensions given by the Engineer, and, unless otherwise specified, the details shall be those given in Economic Paper No. 28 of the North Carolina Geological Survey.

No mortar that has stood more than forty minutes will be allowed to be used.

Where concrete is to be joined to concrete that has already partially set the contact surface of the latter shall be thoroughly wet and covered with a coating of neat cement paste.

All concrete while setting must be protected from freezing and from hot sunshine. It must be sprinkled twice each day for four days, or longer if required by the Engineer, unless kept sufficiently wet by rain.

The contract price for all culverts and drains shall include all necessary excavation, all required materials, laying or constructing the culverts according to specifications, and backfilling to the original surface of the ground, or to bottom of side ditch in case of lateral drains.

Cement.—All cement used on the work embraced by this contract shall be of a standard brand of Portland cement, and shall be accompanied by a certificate from the dealer showing when it was shipped from the mills.

It shall be stored where it will be protected from the weather and in such a manner that each shipment shall be kept separate from the others.

The Engineer shall at all times have access to the cement for the purpose of testing it.

At least three samples of each shipment shall be furnished the Engineer for the purpose of testing.

The tests shall be: first, for fineness; second, for constancy of volume; third, for tensile strength; fourth, chemical tests.

Fineness.—The fineness shall be such that not less than ninety-eight (98) per cent by weight shall pass through a No. 50 standard sieve, having 2,500 meshes per square inch, and not less than ninety-one (91) per cent by weight shall pass through a No. 100 standard sieve, having 10,000 meshes per square inch.

Constancy of Volume.—Pats of neat cement paste about three inches in diameter, one-half inch thick at the middle, and tapering to a thin edge shall be exposed in moist air at normal temperature. One pat is then to be kept in water and one in moist air for seven days, and one in steam above boiling water for five hours. At the end of the tests the pat shall, to meet the requirements, be hard and show no signs of distortion, checking, cracking, or disintegration. Where there is sufficient time two pats shall be kept twenty-eight days, one in water, one in air, before the cement is used in construction.

Tensile Strength.—Briquettes of neat cement mixed three minutes and pressed firmly into the molds, and kept twenty-four hours in moist air at a temperature not lower than 65 F., and in water six days, shall show a tensile strength of at least five hundred (500) pounds per square inch.

Chemical Tests.—The Commission may have chemical analyses made and reject any cement which shows adulterations or excess of ingredients which, in its judgment, renders it unsuitable for the work.

Steel.—Mesh reinforcement and deformed bars shall be placed where specified in the plans or where ordered by the Engineer. Both shall be of mild steel and of the sizes and weights per square foot specified. All reinforcement shall be placed so as to distribute, as nearly as possible, the load equally throughout the reinforcement.

Steel Bridges.—The design and specifications for steel bridges shall be embodied in a supplemental set of specifications which shall become a part of these specifications when attached hereto and properly signed.

Blanks Used in Iredell County.

The following blanks have been found very satisfactory for the work in Iredell County,* which had an organization similar to that described in this paper. The first blank is one that is used in obtaining rights-of-way for highways without any compensation to owners. The second is an agreement that is signed by persons living along the proposed road, when it has been impossible to obtain signatures to the previous documents of all land owners along the proposed road. Thus far, but very little has had to be paid for right-of-way, and in nearly all cases land-owners have been perfectly willing to sign these papers, in order to get the good road constructed:

* These blanks were prepared by W. S. Fallis, Highway Engineer.

No. U 150.

ROAD PETITION.

WHEREAS, THE PUBLIC ROAD has been designated by the Board of Commissioners of Iredell County as a proper road for immediate survey, location and building; and, whereas, it may be necessary, at many points, to survey, locate, relocate and widen said road, in order to a successful completion thereof, for the benefit of the greatest number of people in the community through which it is to be surveyed, located, relocated and built; and, whereas, we desire the completion of said road at the earliest possible moment, and the greatest number of miles of said road built out of the money to be expended for roads

NOW, THEREFORE, we, the undersigned citizens and property owners along the route of said proposed road, do hereby show our appreciation and coöperation in the progressive spirit of the county in the surveying, locating, relocating and building of said road, by granting to the county of Iredell, through its proper authority, permission to enter upon our land, survey, locate, relocate and build said road, as may be deemed advisable by said county authorities, without any compensation to us, and by reason of the construction of said road, doing as little damage as possible to the freeholders along said proposed public road.

IN TESTIMONY WHEREOF, we set our hands to this, the.....day of July, 1911.

.....

.....

.....

.....

.....

AGREEMENT.

Statesville, N. C., ..., 191...

TO THE BOARD OF COUNTY COMMISSIONERS
OF IREDELL COUNTY:

Gentlemen: The party whose name or names are signed hereto mutually and severally offer and agree to hold the county of Iredell free from all cost that may be occasioned and made necessary (by the present survey) in order to obtain the "right of way" over the lands of.....

.....

for the purpose of constructing the new road known as the.....

road between and

The above offer and agreement is made in consideration of the early construction of the said road, and that it be constructed on the survey as now made. The amount of any cost or damage allowed for the right of way over the above land we offer and agree to pay, provided, that the county proceed to have the amount legally adjusted as provided by law.

.....

.....

.....

The third blank is a form of contract used for hiring teams. This is signed in duplicate: one, a white sheet, is retained by the County Road

Commission, and the duplicate, a yellow sheet, is retained by the contractor:

CONTRACT FOR HIRING TEAMS.

This Agreement, made and concluded this the day of....., 191..., between the county of Iredell, State of North Carolina, through and in the person of the County Engineer of said county, or his properly authorized agent or representative, as the party of the first part, and..... as party of the second part,

Witnesseth, That for and in consideration of the money to be paid the party of the second part by the party of the first part, at a rate per hour or day as hereinafter agreed upon, the party of the second part shall furnish to the county..... team or teams, consisting of two... each, together with harness and driver for same, and the period of such employment shall be from.....to..... The team or teams so hired by the party of the first part shall be cared for, stabled, and fed by the party of the second part at his own proper cost and expense, and the party of the first part shall have the right to use said team anywhere, during the continuance of this contract, within a radius of.....miles of

The aforesaid team or teams shall be used by the county continuously every day unless prevented by weather conditions or other unavoidable causes incident to the carrying on of the work.

If the County Engineer is of the opinion that the team so furnished, or the driver or the harness so furnished, is unfit for the work required, the party of the second part shall, upon being so informed, at once replace them with others that shall be satisfactory to the foreman in charge of the work.

The drivers of the team or teams shall be able-bodied men, not less than eighteen years of age, and when not engaged in handling their teams shall do such other work as the foreman shall direct, and shall in all respects be subject to the discipline of said foreman during the hours engaged on the work.

The teams shall work the same number of hours worked by the teams owned by the county, not ordinarily to exceed ten hours per day.

It is hereby SPECIALLY UNDERSTOOD AND AGREED between both parties to this contract that the party of the first part shall retain out of any money that is due, or may become due, to the party of the second part, the sum of ten dollars (\$10.00) to protect the party of the first part from loss, acknowledged and agreed to by the party of the second part, as follows: Should any team of the party of the second part be late in reaching the location of the work where it is understood that work is to be or is being done, or at such place as the foreman instructs the driver of such team to be, the sum of one dollar (\$1.00) shall be deducted for each hour or fractional part of an hour such team is late. Should the team or teams of the party of the second part be absent for an entire day during the continuance of this contract the party of the first part shall have the right to cancel this contract, and the entire sum of ten dollars (\$10.00) be deducted from the amount due said party of the second part, and the party of the second part hereby releases all right and claim to such sum deducted.

This contract shall be signed by the foreman in charge of the work and

shall be considered the agent or representative of the county in connection herewith.

The rate per hour for the service of the above team or teams shall be..... per hour for each team with harness and driver included.

Witness..... Foreman.

 Party of the Second Part.

The fourth blank is a form used for monthly report of county road work, which is made out by each foreman, handed in to the superintendent, and then transferred by him without criticisms to the Chief Engineer (page 97).

The fifth blank is the form of pay roll, that has been found very satisfactory, which is made out in triplicate: the white sheet is sent to the Treasurer of the Road Commission; the green one is posted at camp; and the yellow one is retained in the book by the foreman, which is signed by the employees. These blanks are checked up and signed by the foreman.

Similar pay roll sheets are used for grading, and all forms of construction work (pages 98 and 99).

MONTHLY REPORT OF IREDELL COUNTY ROAD WORK.

CAMP No.		 191				Work Begun		 191	
Name of Road		Sta. No.	to	Sta. No.	Per Cent Complete	Sta. No.	to	Sta. No.	Per Cent Complete
Grading									
Clearing									
Completed Culverts		Sta. No.		Sta. No.	Size and Kind	Sta. No.			Size and Kind
Soil Used		From Mr.		From Mr.		From Mr.			
Completing Road		Sta. No.	to	Sta. No.		Sta. No.	to	Sta. No.	
		Acres			Acres			Acres	
		From Mr.		From Mr.		From Mr.			
		Sta. No.	to	Sta. No.		Sta. No.	to	Sta. No.	
		Acres			Acres			Acres	
Days Worked		For Two Weeks Ending.....				Two Weeks Ending.....			
Days Idle									
Remarks :—		Foreman							

IREDELL COUNTY ROAD PAY ROLL

Camp No.

191

For Week Ending

CLEARING.

NAMES	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Total Time	Price Per Hour	Amount	Signatures
1																		1
2																		2
3																		3
4																		4
5																		5
6																		6
7																		7
8																		8
9																		9
10																		10
11																		11
12																		12
13																		13
14																		14
15																		15
16																		16
Total,																		

BRIDGES AND CULVERTS.

NAME	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Weeks Time	Total Time	Price Per Hour	Amount	Signatures
1																		1
2																		2
3																		3
4																		4
5																		5
6																		6
7																		7
8																		8
9																		9
10																		10
11																		11
12																		12
13																		13
14																		14
15																		15
16																		16
Total,																		

Remarks :—

Foreman

Forms Used by Vance County Road Commission.

(This county does the work with its own forces.)

AGREEMENT.STATE OF NORTH CAROLINA,
VANCE COUNTY.*To the Good Roads Commission of Vance County:*

GENTLEMEN:—The party whose name or names are signed hereto mutually and severally offer and agree to hold the county of Vance free from all cost that may be occasioned and made necessary (by present survey) in order to obtain the "right of way" over the land of.....
.....
..... for the purpose of constructing the new road known as the.....
road between and

The above offer and agreement is made in consideration of the early construction of said road, and that it be constructed on the survey as now made. The amount of any cost allowed for land used for the right of way over the above land we offer and agree to pay, provided, that the county proceed to have the amount legally adjusted as provided by law.

..... (Seal.)
[Signature lines repeated.]

STATE OF NORTH CAROLINA,
VANCE COUNTY.

Whereas, the Public Road has been designated by the Board of Road Commissioners of Vance County, as a proper road for immediate survey, location and building, and whereas, it may be necessary, at many points, to survey, locate, relocate and widen said road, in order to a successful completion thereof for the benefit of the greatest number of people in the community through which it is to be surveyed, located, relocated and built, and whereas, we desire the completion of said road at the earliest possible moment, and the greatest number of miles of said road built out of the money to be expended for roads:

Now, Therefore, We, the undersigned citizens and property owners along the route of said proposed road, do hereby show our appreciation and co-operation in the progressive spirit of the county in the surveying, locating, relocating and building of said road, by granting to the county of Vance, through its proper authority, permission to enter upon our land, survey, locate, relocate and build said road, as may be deemed advisable by said county authorities, without any compensation to us, and by reason of the construction of said road, doing as little damage as possible to the freeholders along said proposed public road.

In testimony whereof, we set our hands to this the.....day.....
191.....

..... (Seal.)
[Signature lines repeated.]

MONTHLY REPORT VANCE COUNTY ROAD WORK.

GOOD ROADS INSTITUTE

103

CAMP No.-----		-----191-----	
Name of Road		Work Begun	
		191	
Grading	Sta. No. to Sta. No.	Per Cent Complete	Sta. No. to Sta. No. Per Cent Complete
Clearing			
Completed Culverts	Sta. No.	Size and Kind	Sta. No. Size and Kind
Soil Used	From Mr.	From Mr.	From Mr.
Completing Road	Sta. No. to Acres	Sta. No. to Acres	Sta. No. to Acres
	From Mr.	From Mr.	From Mr.
	Sta. No. to Acres	Sta. No. to Acres	Sta. No. to Acres
Days Worked	For Two Weeks Ending	For Two Weeks Ending	
Days Idle			
Remarks :—	Foreman		

Under "Remarks" Report any items or features of work not specified above.

STATE AID ROAD.

FOREMAN'S WEEKLY REPORT.

.....County.	Week Ending.....191...
.....Post Office.	Foreman.....

CLEARING AND GRUBBING.

.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....teams.....days @ \$.....per day	. . . \$.....

Total \$.....

Clearing and grubbing has been done between Station..... and Station

GRADING.

.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....teams.....days @ \$.....per day	. . . \$.....
.....teams.....days @ \$.....per day	. . . \$.....

Total \$.....

Grading has been done between Station..... and Station.....

SURFACING.

.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....roller men.....days @ \$.....per day	. . . \$.....
.....teams.....days @ \$.....per day	. . . \$.....
.....teams.....days @ \$.....per day	. . . \$.....
Coal.....tons @ \$.....per ton	. . . \$.....
Gasoline.....gals. @ \$.....per gal.	. . . \$.....

Total \$.....

Surfacing has been done between Station.....and Station.....

CULVERTS AND BRIDGES.

.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....men.....days @ \$.....per day	. . . \$.....
.....teams hauling...days @ \$.....per day	. . . \$.....

Total \$.....

No. cu. yds. gravel, sand or rock used in culverts.....@ \$.....	\$.....
Number sacks cement used.....@ \$.....per sack	\$.....
Number feet B. M. Lumber used in bridges or forms.....	\$.....

Number pounds reinforcing or steel beams used.....	\$.....
Culvert work has been done at Stations.....	
No. feet 12-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 15-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 18-inch pipe put in.....@ \$.....per lin. foot	\$.....
No. feet 24-inch pipe put in.....@ \$.....per lin. foot	\$.....
Total	\$.....

Pipe has been put in at Stations.....

FORCE ACCOUNT.

.....men.....days @ \$.....per day . . .	\$.....
.....men.....days @ \$.....per day . . .	\$.....
.....men.....days @ \$.....per day . . .	\$.....
.....teams.....days @ \$.....per day . . .	\$.....
Total	\$.....

Force account has been done at Stations.....

STATE AID ROAD.
WEEKLY TIME SHEET.

County. For Week Ending-----191-----

[illegible]

Approved :—

The above account is true and correct.

-----Resident Engineer. Foreman

STATE AID-----COUNTY.

LABOR PAY ROLL.

For Labor Pay Roll.

County, Dr.,

To-

Approved for payment.

I hereby certify that this pay roll is correct and the amounts are correct, due and unpaid.

Resident Engineer.

State Highway Engineer.

The following bids which were made by contractors on certain work in Greene County, Tennessee, are of interest as giving some idea of contract prices:

EIGHT BIDS SUBMITTED ON CONTRACT WORK IN GREENE COUNTY, TENNESSEE, IN 1913.

	1	2	3	4	5	6	7	8
For clearing, per acre.....	\$25.00	\$25.00	\$25.00	\$20.00	\$30.00	\$25.00	\$25.00	\$27.00
For grubbing, per acre.....	30.00	25.00	25.00	40.00	100.00	40.00	30.00	30.00
For earth excavation, per cu. yd...	.24	.22 $\frac{7}{8}$	.23	.23	.23	.23 $\frac{1}{2}$	.24	.23
For loose rock excavation, per cu. yd.....	.39	.38 $\frac{1}{2}$	.38	.37 $\frac{1}{2}$	.36	.40	.38	.39
For solid rock excavation, per cu. yd.....	.89	.82 $\frac{1}{2}$	.78	.75	.77	.85	.80	.79
For second-class masonry, per cu. yd.....	6.00	8.00	6.75	7.00	7.00	8.00	7.00	7.00
For culvert masonry in cement, per cu. yd.....	5.00	8.50	6.50	5.00	6.00	7.00 6.00	4.50	5.00
For furnishing and laying rip-rap where designated, per cu. yd.....	1.50	2.00	2.00	2.50	2.00	1.75	1.50	1.50
For paving ditches and culverts where designated, per cu. yd.....	1.75	2.25	2.00	2.00	2.00	2.25	2.00	1.75
For furnishing and putting in place all lumber under 1,000'.....	30.00	38.00	30.00	40.00	50.00	30.00	35.00	30.00
For furnishing and putting in concrete when designated, per cu. yd.	9.00	8.50	9.00	9.00	8.00	10.00	9.00	10.00

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*
23. Forest Conditions in Western North Carolina, by J. S. Holmes 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nerst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum, Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled

by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1st, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8° 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 40

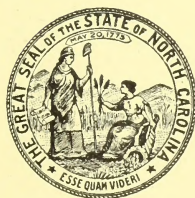
FOREST FIRES IN NORTH CAROLINA
DURING 1914

AND

FORESTRY LAWS OF NORTH CAROLINA

BY

J. S. HOLMES, State Forester



RALEIGH

E. M. UZZELL & Co., STATE PRINTERS AND BINDERS

1915

N
55-7
N813e

GEOLOGICAL BOARD.

GOVERNOR LOCKE CRAIG, *ex officio* chairman.....Raleigh
FRANK R. HEWITT.....Asheville
HUGH MACRAE.....Wilmington
HENRY E. FRIES.....Winston-Salem
JOHN, SPRUNT HILL.....Durham

JOSEPH HYDE PRATT, State Geologist.....Chapel Hill

LETTER OF TRANSMITTAL.

CHAPEL HILL, July 15, 1915.

To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.

SIR:—I have the honor to submit for publication as Economic Paper No. 40 of the reports of the North Carolina Geological and Economic Survey a report on the *Forest Fires in North Carolina During 1914* and on the *Forestry Laws of North Carolina*.

Since the passage of the forestry laws by the General Assembly of 1915, there has already been an increased interest shown in regard to the forests of the State and their preservation. It is believed that these laws can be made effective and that they will be the means of greatly reducing the loss due to forest fires.

Yours very respectfully,

JOSEPH HYDE PRATT,
State Geologist.

CONTENTS.

FOREST FIRES IN NORTH CAROLINA DURING 1914:

Introduction	7
The Weather	8
Relative Monthly and Seasonal Fire Risks (Table 1)	9
Annual Statement of Forest Fires in 1914	9
Summary of Reports by Regions. Comparative Statement (Table 2)	10
Summary of Reports by Counties:	
Mountain Region (Table 3)	10
Piedmont Region (Table 4)	11
Coastal Plain Region (Table 5)	12
Comparative Statement of Averages by Regions (Table 6)	13
Causes of Forest Fires. Comparative Statement (Table 7)	13
Organized Fire Protection	14
Results of Federal Protection in North Carolina	15
Forest Fires in the Southern Appalachian Purchase Areas (Table 8)	15
Results of Partial Protection	16
Damage in Partially Protected Areas (Table 9)	16

FORESTRY LAWS OF NORTH CAROLINA:

Introduction	18
The State Geological Board	18
Law Creating the State Geological and Economic Survey	19
Laws for the Protection of the Forests from Fire	21
The Law of 1777	21
More Recent Attempts to Secure Effective Laws	22
The New Forest Fire Law	24
Administration	26
Coöperation	26
Appointment of Forest Wardens	27
Prosecutions	28
Duties of Forest Wardens	29
Patrol	30
The Power of Arrest	30
Assistance in Fighting Fires	31
Compensation of Forest Wardens	31
Additional Protection to City Water Supplies	32
The Law for the Protection of City Watersheds	33

FORESTRY LAWS OF NORTH CAROLINA :

Laws for the Creation of State Forests.....	34
Needs for Demonstration in Forestry.....	34
The Law Governing the Acquirement and Administration of	
State Forests.....	35
Gifts of Land for State Forests.....	36
Purchasing State Forests.....	37
Some Problems to Be Solved.....	38
Further Benefits of State Forests.....	39
Mount Mitchell State Park.....	39
The Mount Mitchell Park Purchase Law.....	40
Fire Protection Needed.....	42
The Commission.....	42
Appalachian National Forests.....	42
Law to Allow Federal Acquirement.....	43
Acquirement by Purchase Only.....	43
Protection of Game on National Forests.....	44
Law to Allow Federal Protection of Wild Life.....	44
Arbor Day.....	46
Arbor Day Law.....	46
Manner of Observance.....	48

FOREST FIRES IN NORTH CAROLINA DURING 1914

INTRODUCTION.

Public interest in forest fire prevention in North Carolina is increasing year by year. This is reflected in the State press, which chronicles and comments upon forest fires and the loss suffered by them to a much greater extent than formerly. It is also seen in the recent action of the State Legislature, which enacted an excellent forest fire law. However, the fact that the appropriation to make this law effective was denied shows that even yet public opinion is not insistent enough or definite enough to secure from the representatives of the people in the General Assembly adequate State assistance in fire protection.

The only possible reason for this condition is that our people themselves are not well enough informed on this subject. They do not yet realize the pressing necessity for a permanent supply of timber for our industries and for the people as a whole. They do not yet understand that where seedlings and young trees of our more valuable species are killed by fire our future forests will be of greatly reduced value; that burnt-over forests yield the minimum returns in timber, while protected forests yield the maximum; that unburnt forests pay the highest returns to the owners, to the community, and to the State.

Forest fires result largely from the indifference and consequent carelessness of the people. Half the fires in this State are said to be due to the carelessness of the individual. By changing this indifference into strong, active opposition to burning the woods, much of the criminal carelessness now existing in regard to forest fires will be done away with. It is with the idea of keeping the public informed as to the real conditions of the forests throughout the State, and so arousing them to the need of definite action, that these annual reports continue to be prepared and issued to the people of the State. Previous publications of the North Carolina Geological and Economic Survey in this series are "Forest Fires in North Carolina During 1909," Economic Paper No. 19; "Forest Fires in North Carolina During 1910," Economic Paper No. 22; "Forest Fires in North Carolina During 1911," Economic Paper No. 25; "Forest Fires in North Carolina During 1912," Economic Paper No. 33; and "Forest Fires in North Carolina During 1913," Economic Paper No. 37. Each of these reports contains a large amount of information about the nature of the damage done by forest fires, the causes

of fires, the various methods suggested and plans put into force to prevent them, and the laws of the various States and of the United States for their control. Copies of most of these Economic Papers can be had free upon application.

THE WEATHER.

Extremely dry weather has often been spoken of as a frequent cause of forest fires. This, however, is a misapprehension. Dry weather can no more cause a fire in the woods than a loaded gun can cause the death of a friend. It is the careless individual in both cases who causes the trouble. If carelessness could be eliminated, the forest fire "caused by dry weather" and the death caused by the gun which was "not loaded" would not occur.

But carelessness can only be overcome with thoughtfulness. In order, therefore, to reduce the number of fires, knowledge of the damage done by them must be spread and emphasized so that the general public will learn to think, and so will learn to exercise increased watchfulness and care.

The relation of carelessness and dry weather to forest fires in 1914 is seen in a casual perusal of the State press; though even now, when a knowledge of the value of our forests would seem to be almost universal, some newspapers, which claim to be leaders of public opinion, scarcely notice even the worst fires. The great majority of our State papers, however, are quick to point a lesson from each destructive fire. It is seen, by referring to the annual summary of the United States Weather Bureau reports, that the precipitation over North Carolina for the past year was "2.79 inches below normal," a deficiency of about 5½ per cent. January was a dry month, there being only about two-thirds the normal amount of rainfall. From the 4th to the 24th practically no rain fell. A very destructive fire occurred near Ridge Crest which was caused, it was said, by "careless handling of fires in the woods."

During February rainfall was about normal, but in March there was only two-thirds of the usual amount. It was, however, well distributed, and few fires were reported. The April rainfall was normal, most of it occurring, however, before the 21st of the month. From that date up to the middle of June precipitation was exceptionally light. May was the driest on record, with the exception of 1911, an average of only 1.38 inches falling, compared with a normal rainfall of 4.11 inches. The western district, usually the wettest, was drier than the central or eastern sections, and precipitation was unevenly distributed. Forest fires were reported by the newspapers from the Linville section of the mountains

and from many of the southeastern coastal plain counties. The June rainfall averaged 3.28 inches, being about 2 inches below the normal. Though rain was general about the middle of the month, forest fires raged around Beaufort up to about the 20th. They were, also, exceedingly destructive on Mount Mitchell. July was also dry, and though scattered showers fell in most places, destructive fires still continued over the greater part of the coastal plain region.

The rainfall through August and September was still below normal, but no fires were reported in the daily papers.

The last three months of the year were the only ones in which the precipitation was above the average, the December rainfall being easily the heaviest yet recorded. Early in November fierce fires were raging around the Black Mountains and at other places in the State, but the fall fires were less numerous than usual.

TABLE 1.—RELATIVE MONTHLY AND SEASONAL FIRE RISKS IN 1914 AND AVERAGE FOR FOUR YEARS IN PERCENTAGES.

	1914.	Average.		1914.	Average.
March.....	15	16.5	} Spring.....	52	53.5
April.....	20	23			
May.....	17	14			
June.....	11	6.5	} Summer.....	21	17
July.....	5	6			
August.....	5	5			
September.....	4	5	} Fall.....	21	22.5
October.....	7	7			
November.....	10	10.5			
December.....	1	3	} Winter.....	6	7
January.....	1	1			
February.....	4	2.5			

ANNUAL STATEMENT OF FOREST FIRES IN 1914.

The following tables were compiled from more than six hundred replies from voluntary correspondents all over North Carolina. Though five counties only are unrepresented, less than half the townships of the State were reported for, and most of these by only one person. Nevertheless, the figures here given, though undoubtedly much less than the actual amount of fire damage, will convey to the reader some idea of the destruction annually occurring in our State, largely as a result of carelessness.

TABLE 2.—FOREST FIRES IN NORTH CAROLINA DURING 1914. COMPARATIVE STATEMENT; SUMMARY OF REPORTS FROM CORRESPONDENTS BY REGIONS.

	MOUNTAIN.		PIEDMONT.		COASTAL PLAIN.		STATE.	
	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.
Total number of townships in region.....	166	-----	454	-----	370	-----	990	-----
Number of townships reporting.....	85	68	234	196	129	128	448	390
Number of replies received.....	117	83	348	240	161	128	626	452
Number of forest fires reported.....	176	170	212	230	281	238	669	639
Total area burnt over, in acres.....	76,000	141,000	60,000	101,000	159,000	155,000	295,000	397,000
Total standing timber destroyed, in M feet, board-measure.....	18,000	23,000	6,000	11,000	23,000	22,000	47,000	56,000
Value of timber destroyed.....	\$ 29,000	\$ 58,000	\$ 17,000	\$ 33,000	\$ 83,000	\$ 63,000	\$129,000	\$ 155,000
Area of young growth destroyed, in acres.....	31,000	47,000	21,000	32,000	48,000	42,000	100,000	122,000
Value of young growth destroyed.....	\$ 67,000	\$ 68,000	\$ 42,000	\$ 59,000	\$111,000	\$ 77,000	\$220,000	\$ 207,000
Value of forest products destroyed.....	\$ 87,000	\$ 73,000	\$ 26,000	\$ 54,000	\$ 72,000	\$ 84,000	\$185,000	\$ 212,000
Value of improvements destroyed.....	\$ 22,000	\$ 17,000	\$ 13,000	\$ 22,000	\$ 31,000	\$ 26,000	\$ 66,000	\$ 66,000
Total damage reported.....	\$205,000	\$218,000	\$ 98,000	\$170,000	\$297,000	\$253,000	\$600,000	\$ 641,000
Number of lives lost.....	-----	-----	-----	-----	-----	-----	-----	2
Cost to private individuals to fight fires.....	\$ 4,400	\$ 6,000	\$ 1,900	\$ 4,400	\$ 9,000	\$ 8,100	\$ 15,000	\$ 18,600

TABLE 3.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES.

MOUNTAIN REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Alleghany.....	8	1	1	-----	-----	-----	\$-----	-----	\$-----	\$-----	\$-----	\$-----
Ashe.....	15	4	2	4	500	-----	-----	500	2,000	-----	100	100
Avery.....	7	3	4	3	200	-----	-----	150	1,000	1,000	500	50
Buncombe.....	13	6	9	16	4,100	15,000	10,000	4,080	3,762	10,000	-----	130
Cherokee.....	6	2	3	13	1,100	10	25	500	500	-----	-----	25
Clay.....	5	4	11	19	5,500	272	1,200	3,450	9,500	-----	-----	100
Graham.....	3	2	2	3	4,000	100	300	3,000	1,000	-----	-----	-----
Haywood.....	13	5	6	12	3,700	620	3,000	200	200	4,500	600	1,050
Henderson.....	8	6	7	1	100	-----	-----	3	25	-----	150	-----
Jackson.....	15	3	4	9	6,650	35	6,175	200	3,000	-----	-----	1,273
Macon.....	11	8	14	18	11,515	25	85	1,708	4,008	-----	11,204	182
Madison.....	16	11	13	6	3,155	523	2,075	320	1,052	780	1,050	135
Mitchell.....	9	5	8	3	300	25	190	50	40	100	100	-----
Swain.....	5	3	3	13	16,600	116	250	6,500	7,400	7,000	1,000	575
Transylvania.....	9	7	10	46	3,050	1,025	4,120	2,615	8,000	13,170	100	100
Watauga.....	12	6	6	3	200	50	250	-----	-----	-----	-----	25
Yancey.....	11	9	14	7	16,530	373	1,130	7,530	25,800	51,000	7,050	590
Totals.....	166	85	117	176	76,250	18,174	\$28,800	30,806	\$67,287	\$87,550	\$21,854	\$ 4,335

TABLE 4.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES.

PIEDMONT REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Alamance.....	13	8	12	---	---	---	\$.	---	\$.	\$.	\$.	\$.
Alexander.....	8	7	8	3	12	---	---	10	25	150	100	---
Anson.....	8	---	---	---	---	---	---	---	---	---	---	---
Burke.....	12	5	6	4	21,200	1,250	2,500	11,200	25,200	25	---	300
Cabarrus.....	12	7	11	1	5	5	25	5	10	35	---	---
Caldwell.....	12	3	4	15	11,100	300	1,500	1,000	1,000	3,000	---	---
Caswell.....	9	5	7	4	129	---	---	---	250	50	---	---
Catawba.....	8	7	11	---	---	---	---	---	---	---	---	---
Chatham.....	14	4	5	6	170	---	---	135	695	---	---	---
Cleveland.....	11	7	10	5	218	20	48	217	55	250	---	20
Davidson.....	17	6	8	1	12	15	30	12	100	100	---	10
Davie.....	7	7	15	2	310	12	60	8	75	400	---	---
Durham.....	6	2	2	---	---	---	---	---	---	---	---	---
Forsyth.....	14	10	13	4	41	10	50	30	275	350	---	12
Franklin.....	10	4	9	6	131	250	850	99	216	100	100	50
Gaston.....	6	4	8	4	195	6	24	135	650	225	---	70
Granville.....	9	5	9	---	---	---	---	---	---	---	---	---
Guilford.....	18	8	10	2	85	---	100	60	150	---	---	---
Iredell.....	16	6	10	1	860	100	500	200	150	300	450	75
Lee.....	7	2	2	10	623	---	---	603	760	---	---	---
Lincoln.....	5	3	4	2	---	---	---	50	100	---	800	---
McDowell.....	11	5	6	25	1,420	1,000	3,003	410	205	---	---	150
Mecklenburg.....	15	10	18	---	---	---	---	---	---	---	---	---
Montgomery.....	11	7	8	23	8,920	15	30	130	440	491	25	170
Moore.....	9	7	15	11	4,130	103	410	1,800	1,750	2,350	---	280
Orange.....	7	2	2	---	---	---	---	---	---	---	---	---
Person.....	9	4	4	---	---	---	---	---	---	---	---	---
Polk.....	6	6	8	9	3,180	20	2,410	2,300	2,600	1,500	600	75
Randolph.....	19	7	8	6	1,000	100	300	200	500	---	---	---
Rockingham.....	11	4	5	11	27	10	40	21	205	100	1,000	100
Rowan.....	14	9	12	12	760	1,000	1,100	320	1,300	650	5,300	130
Rutherford.....	12	3	3	---	50	---	---	50	100	10	---	10
Stanly.....	8	2	2	2	10	20	75	6	50	250	2,000	100
Stokes.....	8	4	5	3	3,501	100	500	200	500	---	---	50
Surry.....	14	12	15	4	540	202	410	510	625	35	---	75
Union.....	9	7	9	2	204	75	200	75	200	400	500	---
Vance.....	9	5	7	2	7	---	---	4	30	---	---	---
Wake.....	19	2	2	1	10	5	15	10	50	---	---	---
Warren.....	12	5	10	13	150	100	300	95	1,175	2,500	75	55
Wilkes.....	21	15	26	13	990	915	2,415	800	2,750	12,300	1,000	185
Yadkin.....	8	8	19	5	200	100	100	210	25	---	1,035	---
Totals.....	454	234	348	212	60,190	5,733	\$16,995	20,905	\$42,216	\$25,571	\$12,985	\$ 1,917

TABLE 5.—FOREST FIRES IN NORTH CAROLINA DURING 1914. SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES.

COASTAL PLAIN REGION.

County.	Total Number of Townships in County.	Number of Townships Reporting.	Number of Replies.	Number of Fires.	Total Number of Acres Burnt Over.	Merchantable Timber Destroyed, M.	Value Timber Destroyed.	Acres of Young Growth Destroyed.	Value of Young Growth Destroyed.	Value of Products Destroyed.	Value of Improvements Destroyed.	Cost of Fighting Fires.
Beaufort.....	6	2	3	10	2,000	2,000	\$8,000	2,000	\$ 6,000	\$6,000	\$.....	\$ 1,000
Bertie.....	9	7	10	6	1,860	115	333	710	820	1,100	200	100
Bladen.....	15	1	1	1	200	10	40	100	300	-----	-----	50
Brunswick.....	6	1	2	2	1,200	-----	6,000	-----	3,000	-----	-----	-----
Camden.....	3	1	1	1	-----	-----	-----	-----	-----	-----	-----	-----
Carteret.....	9	2	2	1	-----	-----	-----	-----	-----	-----	-----	250
Chowan.....	4	2	2	-----	-----	-----	-----	-----	-----	-----	-----	-----
Columbus.....	14	8	11	24	12,600	775	1,600	6,600	500	3,100	3,000	1,085
Craven.....	9	2	2	-----	2,000	-----	-----	-----	-----	-----	-----	-----
Cumberland.....	11	4	4	14	52,000	3,050	9,150	10,500	25,550	10,100	5,000	1,150
Currituck.....	5	3	4	11	5,002	-----	-----	2	50	-----	510	-----
Dare.....	5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Duplin.....	13	5	5	2	-----	-----	-----	-----	-----	-----	-----	-----
Edgecombe.....	14	2	2	2	200	50	25	5	50	100	500	25
Gates.....	7	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	-----
Greene.....	9	3	3	4	350	3	3	75	-----	-----	-----	-----
Halifax.....	12	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Harnett.....	13	8	10	5	1,800	200	550	25	250	1,300	100	25
Hertford.....	6	1	1	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hoke.....	5	1	1	1	1,000	-----	-----	-----	-----	-----	-----	20
Hyde.....	4	2	4	-----	-----	-----	-----	-----	-----	-----	-----	-----
Johnston.....	17	7	12	12	750	50	150	700	1,500	-----	50	-----
Jones.....	7	2	2	3	1,000	100	200	1,000	500	-----	-----	100
Lenoir.....	12	7	8	8	400	4	16	300	650	8	200	10
Martin.....	10	2	2	2	10,000	100	200	-----	-----	-----	-----	-----
Nash.....	14	6	8	47	2,300	1,580	7,600	1,700	12,450	24,150	15,300	1,100
New Hanover.....	4	-----	-----	4	-----	-----	-----	-----	-----	-----	-----	-----
Northampton.....	9	5	6	6	860	-----	-----	150	300	2,500	-----	300
Onslow.....	5	3	4	26	14,000	2,500	11,500	4,500	24,500	1,000	400	1,100
Pamlico.....	4	2	2	6	2,325	1,500	4,000	400	1,600	1,500	2,000	10
Pasquotank.....	6	1	1	1	100	50	300	100	300	300	-----	-----
Pender.....	10	4	6	20	13,250	835	1,780	6,050	16,050	640	300	300
Perquimans.....	5	2	2	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pitt.....	11	3	6	9	12,200	30	90	3,000	6,500	-----	-----	10
Richmond.....	7	1	1	2	500	-----	-----	-----	-----	500	500	100
Robeson.....	19	7	10	22	10,700	2,800	8,000	9,250	7,600	14,000	1,500	1,010
Sampson.....	16	8	7	18	9,250	5,010	21,010	700	1,500	-----	100	1,225
Scotland.....	4	2	2	2	250	-----	2,000	-----	-----	3,500	-----	-----
Tyrrell.....	5	1	1	1	400	100	200	400	500	-----	-----	50
Washington.....	4	3	4	1	50	-----	-----	50	250	-----	-----	-----
Wayne.....	12	6	7	1	10	2,000	5	5	20	20	-----	25
Wilson.....	10	2	2	5	100	100	200	25	200	2,000	1,000	-----
Totals.....	370	129	161	281	158,657	22,962	\$82,954	48,347	\$110,940	\$71,818	\$30,660	\$ 9,045

TABLE 6.—FOREST FIRES IN NORTH CAROLINA DURING 1914. COMPARATIVE STATEMENT OF AVERAGES BY REGIONS FOR 1914 AND FOR SIX YEARS.

	MOUNTAIN.		PIEDMONT.		COASTAL PLAIN.		STATE.	
	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.	1914.	Average for Six Years.
Percentage of townships reporting.....	51	41	52	43	35	34	45	39.5
Average area of each fire, in acres....	448	898	305	447	583	656	462	624
Average damage by each fire.....	\$1,209	\$1,412	\$ 491	\$ 729	\$1,092	\$1,082	\$ 939	\$ 1,016
Average area burnt over per township reporting, in acres.....	896	*1,649	254	*717	1,230	*1,292	657	*984
Average damage per acre burnt.....	\$ 2.70	\$ 1.50	\$ 1.62	\$ 1.65	\$ 1.87	\$ 1.79	\$ 2.03	\$ 1.60
Average damage per township reporting.....	\$2,417	\$3,302	\$ 411	\$ 861	\$2,297	\$1,565	\$1,335	\$ 1,657

*No township figures for 1909.

TABLE 7.—CAUSES OF FOREST FIRES IN NORTH CAROLINA IN 1914 BY REGIONS, COMPARED WITH SIX YEARS, IN PERCENTAGES.

	1914.				Average for Six Years.
	Mountain.	Piedmont.	Coastal Plain.	State.	
Farmers burning brush, grass, rubbish, etc.....	12	7.5	4	7	11
Hunters.....	19	7.5	8.5	11	11.5
Cigars, cigarettes, matches, etc.....	3	4.5	5	4	3
Carelessness.....	15	13	15	14	18
Railroad locomotives, sparks from.....	8	35	14	20	18.5
Logging locomotives, dummy engines, etc.....	5	2	18	8.5	7
Sawmills, etc.....	3	4.5	2	3	4
Traction engines.....		2		1	.5
Accidental, caught from burning building, etc.....			2	1	.5
To improve the range.....	5	8	7	7	4
Set by chestnut gatherers, root diggers, etc.....	1			.5	1
Without object, "to see it burn".....	3		1	1	3
Malice or incendiary.....	12	4.5	8.5	8	7
Unknown causes.....	5	4.5	10	7	8
Lightning.....		3	4	2.5	1
Loafers, trespassers, etc.....	1	2	1	1.5	1
Campers.....	8	1		2.5	1
Tar kilns.....		1		.5	

The foregoing tables show a total reported damage from forest fires in 1914 of \$600,000, half of which occurred in the coastal plain counties. This is slightly less than the average loss for the past six years, though very near the average in most particulars.

The most encouraging feature is the reduction of 25 per cent in the reported area burnt over, and this in spite of the fact that there were more than the average number of fires. This would indicate that more general efforts are being made to extinguish fires after they have started;

and this is corroborated by the various newspaper accounts of the fires. This interpretation, however, is not borne out by figures of cost to private individuals, who are reported to have spent less money than during the previous year in fighting fires and considerably less than the average amount. The incompleteness of the reports is responsible for this apparent contradiction. For example, a devastating fire occurred in the northern parts of Camden and Gates counties at the end of July, which was not mentioned in the voluntary reports, yet large private expense was incurred in efforts to control it. The *New Bern Journal* says:

"Several hundred men have been rushed to the scene by the Richmond Cedar Works, John L. Roper Company, and Camp Manufacturing Company, principal owners of the timber in the forest tract, to fight the spread of the fire. All operations in near-by camps were suspended by the Cedar Works Company yesterday and 150 men rushed to the fire on special trains."

It seems safe to assume, from all indications, that the people are rapidly becoming more actively opposed to forest fires, and that their changed attitude is already having some effect. Yet there is much to be done by North Carolinians, both as private landowners and as citizens of a sovereign State. In the former rôle there is a large field of usefulness in the practice of coöperative fire protection, while in the latter capacity one of the first duties is to spread a knowledge of and respect for the State forestry laws.

ORGANIZED FIRE PROTECTION.

That organized fire protection, whether private, as was recently practiced on the Biltmore estate, or coöperative, as is now being worked out in Virginia, Kentucky, and other States, or governmental, *i. e.*, State and Federal, can be successfully practiced in North Carolina is being demonstrated afresh on and near the National Forests in the western part of the State. Not only have the local forest officers extinguished many fires on the lands under their charge, but they have fought fires on surrounding lands with the primary object of preventing their spread to the National Forests.

Two extracts taken from the State press show the importance of having experienced men in the neighborhood who can organize and lead fire-fighting forces, who know exactly what to do, and have the authority to go ahead and do it. Speaking of a Buncombe County fire, occurring in January, one newspaper says:

"The fire started near midnight Friday night and had gained great headway before the alarm was spread and the corps was organized to fight it. All the available men in the adjacent territory were organized under the direction of

United States Forester Young and scattered over the district threatened by the leaping flames. Fighting with grim determination and never giving up hope for a single moment, this force finally confined the spreading flames in a certain area, although at times in the early morning it seemed that every residence in a radius of several miles would be destroyed."

Of a November fire in the same region, another newspaper says:

"Forest fires which have been raging in various sections of the mountains around Black Mountain during the greater part of the week are reported to have done considerable damage, the greater number of the outbreaks being reported from the Craggy Mountains. For a while fear was entertained that the flames would get on the immense watershed holdings of the city of Asheville, but reports from the intake are to the effect that but little damage has been suffered by the municipality. Mr. Bishop of Marion, representing the Government, is in charge of a force of 100 men in the Bee Tree section, and back-firing has been resorted to in checking flames."

RESULTS OF FEDERAL PROTECTION IN NORTH CAROLINA.

A striking tribute to the value of organized fire protection is brought out by some figures in Table 6. It is seen that the average area burnt over by each fire in the mountain region during the past year was exactly half the average for the past six years, while in the other regions of the State there has been only a comparatively small reduction. The only way to account for this is that the assistance and example of the Federal forest officers have had a decided effect in reducing the amount of burnt land areas.

This explanation is supported by the figures compiled by the forest officers themselves:

TABLE 8.—FOREST FIRES IN THE SOUTHERN APPALACHIAN PURCHASE AREAS IN NORTH CAROLINA, 1914.

NAME OF FOREST.	AREA OF FOREST.	NUMBER OF FIRES.				LOCATION.				NATIONAL FOREST LANDS.		
		Under 1 Acre.	Under 10 Acres.	Over 10 Acres.	Total.	Fires Originating—				Area Burned Over.	Value of Timber Destroyed.	Value of Reproduction Destroyed.
						Inside Forest.		Outside Forest.				
						On National Forest Lands.	On Private Lands.	Entered Forests.	Confined to Outside Areas.			
Mount Mitchell	66,213	4	6	11	21	5	-----	1	15	372	\$ 36	\$ 169
Pisgah	86,700	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Nantahala	36,973	-----	10	12	22	-----	7	-----	15	-----	-----	-----
Savannah (N).....	34,808	1	1	-----	2	-----	2	-----	-----	1	-----	1
Totals.....	224,694	5	17	23	45	5	9	1	30	373	\$ 36	\$ 170

The above table was prepared from the Federal Forest Examiners' annual reports. It shows the number of fires of different classes occurring within the Federal Purchase Areas in 1914 and the amount of National forest land burnt over.

It will be seen that only six fires occurred on the National Forest lands in North Carolina. The rest probably threatened the Government lands, but were extinguished before they crossed onto them. These six fires burnt over only 372 acres, or an average area for each fire of 62 acres.

RESULTS OF PARTIAL PROTECTION.

Through the coöperation of the Federal Forest officials in western North Carolina accurate information in regard to forest fires in twenty townships or parts of townships surrounding the National Forests was supplied and it is incorporated with all the foregoing tables except the last. Because of the comparative completeness of this information, and in view of the fact that efficient fire protection was practiced over parts of the townships in question, these auxiliary reports have also been compiled by themselves to show the result of partial fire protection.

The Government lands lying within these townships are thoroughly patrolled, and only six fires occurred on them, as shown in Table 8. Private land within the National Forests or outside the forests but within the purchase areas, namely, within the limits set by the Government for making further additions to the National Forests, are not patrolled, but forest officers usually assist in extinguishing fires, especially if Federal lands, or lands which have been offered to the Government, are threatened. There were thirty-nine such fires reported in 1914. The remaining thirty-five fires included in Table 9 probably occurred beyond the Government rangers' field of duty, and so were extinguished in the ordinary way, namely, by private citizens, by rain, or by burning themselves out. The following table, therefore, shows the results of partial protection in the comparison of these figures with the average ones for the mountain region found in Table 6.

TABLE 9.—GENERAL FIRE DAMAGE IN THE MOUNTAINS DURING THE PAST SIX YEARS COMPARED WITH THAT IN PARTIALLY PROTECTED TOWNSHIPS.

	In Townships and Parts of Townships Partially Protected, 1914.	In the Moun- tain Counties as a Whole. Average for the Past Six Years.
Average area of each fire, acres.....	148	898
Average damage by each fire.....	\$ 514.00	\$ 1,412.00
Average damage per acre burnt.....	3.46	1.50
Average cost of fighting fires, per fire.....	11.00	35.00

From the above table it can be seen that the average fire, where only partial protection was given, was one-sixth the size of the average fire of the region, or a saving in the eighty fires reported by the forest officers of 60,000 acres not burnt over. At an average damage of \$1.50 per acre, this means an actual saving of \$90,000.

The saving in cost of fighting fires is just as startling. While it is often said that fire fighting is now done voluntarily in North Carolina, the average cost to fight fires in the mountains is \$35 per fire, borne by landowners and private individuals. In this partially protected area under discussion the cost to private owners and the Government combined has been reduced to \$11 per fire. This seems to be indisputable evidence that organized fire protection will and does pay.

FORESTRY LAWS OF NORTH CAROLINA.*

INTRODUCTION.

The General Assembly of 1915 enacted more legislation for the conservation of our natural resources than any previous one in the history of the State. The eastern fisheries, part of which had been protected, but the greater part exploited almost without restriction, were all put under a State-wide Fisheries Commission. This law ought to insure the growth of our fishing industry which for a long while has been steadily declining. The Highway Commission bill, though not, strictly speaking, a conservation measure, is one of the most complete and effective laws for the encouragement and construction of good roads now in force in the South; and good roads are so closely connected with conservation that it is difficult to separate them.

The new laws connected with forest conservation, though not as complete and effective as the two already mentioned, because unsupported by any appropriation, cover, however, a wider field, and definitely commit the State to two policies, new in North Carolina, though well tried and permanent in many other States of the Union. These policies are: (a) State protection of the private as well as public forest lands of the State from fire, in the same way that cities and towns provide for the protection of the property of their citizens; (b) the purchase and administration of forest land by the State for the purposes of demonstration and experiment, for the recreation, health, and pleasure of its citizens, and for the protection of its streams.

In order that a clear understanding may be had of the administration of the new forest fire law and the "State forest" law, the enforcement of which is intrusted to the State Geological Board, the law creating this board is here introduced.

THE STATE GEOLOGICAL BOARD.

The General Assembly of 1905 reorganized the State Geological Survey, enlarging its scope and changing its name to the State Geological and Economic Survey. At the same time the Survey was given additional powers and duties to those it already possessed dealing with the investigation and development of the natural resources of the State.

*See Press Bulletin No. 147, N. C. Geol. and Econ. Survey, "Forestry Laws of North Carolina."

LAW CREATING THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.*

SECTION 4429. *State Geologist appointed by Governor.* The Governor shall appoint a suitable person as State Geologist to conduct, under the supervision of a board of managers to be known as the Geological Board, a geological and economic survey of the State.

SEC. 4430. *Geological Board, how appointed; meetings.* The Geological Board shall consist of the Governor (as chairman), four citizens of the State, two for a period of two years and two for a period of four years from March 1, 1905, the same to be appointed by the Governor by and with the advice and consent of the Senate, and their successors to be in like manner appointed each for a period of four years. In case of the death or resignation of either of said citizens, his successor shall be appointed by the Governor. The Geological Board shall meet twice each year, once in January and once in June, in the city of Raleigh, on the call of the Governor, except that the board may change the time and place of meeting as circumstances may require.

SEC. 4431. *Experts and assistants.* The State Geologist shall appoint, subject to the approval of the Geological Board, such experts and assistants as may be found necessary to enable him to carry out successfully and speedily the work of the Survey.

SEC. 4432. *Objects of Survey.* The Survey shall have for its objects:

1. An examination of the mineral, forest, fishery, and other material resources of the State.

2. An examination of the geological formations of the State with reference to their economic products.

3. An examination of the road-building materials and the best methods of utilizing the same.

4. An examination and classification of the soils, the forests, and other physical features of the State, with special reference to their bearing upon the occupation of the people.

5. An examination of the streams and water-powers of the State, with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.

6. The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.

7. The preparation of such reports, illustrations, and maps as may be deemed necessary in placing the results of these investigations before the public.

8. And the State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and coöperation from the several United States Government bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this chapter.

9. An examination of the water supplies of the State, with special reference to the sinking of deep or artesian wells.

SEC. 4433. *Reports.* The Geological Board shall cause to be prepared and submitted to each Legislature a report showing the progress and expenditures

*Chapter 94, Revisal of 1905.

of the Survey; it shall also cause to be prepared for publication such other reports, with necessary illustrations and maps, as will adequately set forth the geology and material resources of the State, all such reports, illustrations, and maps to be printed and distributed as the Geological Board may direct in editions of 3,000 copies each at the expense of the State as other public documents.

SEC. 4434. *Appropriation.* The sum of \$10,000 annually, or so much thereof as may be necessary, is hereby appropriated out of any moneys in the Treasury not otherwise appropriated for the purpose of carrying out the provisions of this chapter.

Soon after the passage of this law and the general reorganization of the Survey by the new State Geologist, Joseph Hyde Pratt, three important divisions, *i. e.*, the Highway, the Fisheries, and the Forestry divisions, were made; other interests of the Survey, such as the geological and mining work, were not delegated to any particular division.

The Highway Division has organized and pushed the good roads movement in this State by holding meetings, furnishing speakers in support of local road bond issues, and founding and assisting the North Carolina Good Roads Association. It has administered and carried out the provisions of the highway assistance law (chapter 915, Public Laws 1909) which enables the Geological Board "to advise with the township and county authorities in the building and improvement of the public roads, by sending to the township or county a competent road engineer, who will assist them in locating their improved roads, advise them," etc.

The Fisheries Division has supervised the administration of the old fish commission law (chapter 977, Public Laws 1907), which protected the northern part of Pamlico Sound and the inner waters of Albemarle Sound. It has consistently urged the extension of this law to the whole coast, which, owing to its unceasing efforts, has just been accomplished.

The Forestry Division, which was regularly organized in 1908, has examined and reported on the forests of the State, studied the forest fire question, and continuously urged forest fire legislation, and has effectively aided in the organization and support of the North Carolina Forestry Association. It has taken part in meetings, has issued publications and statements to the press, and carried on general propaganda work. It has at several different times received the coöperation of the United States Department of Agriculture in investigative forestry work.

It seems, therefore, only natural and appropriate that the administration of the forestry law, which has for eight or ten years been unceasingly advocated by the Survey and the need for which has been set forth in most of its forestry publications, should be committed to it. The Forester of the Survey is the only technical forester employed by the

State. He is in close touch with all the forestry work, and especially with the forest fire conditions over the State, as no other man can be.

It has always been the custom for the Governor to appoint the members of the Geological Board without any special reference to their political affiliation, but because of their ability and their knowledge of conditions with which they have to deal. The State Geologist is likewise appointed with the one idea of his fitness for the position, and the employees of the Survey are employed in like manner. The State Geological and Economic Survey is therefore known as a nonpolitical organization, and for this reason is especially suited for carrying on work of a technical character, which, as all experts agree, must for its fullest efficiency be absolutely divorced from politics.

LAWS FOR THE PROTECTION OF THE FORESTS FROM FIRE.

North Carolina is said to have had the first law against setting fire to woods of any State in the Union. Certain it is that in 1777 "at a General Assembly, begun and held at New Bern, on the Eighth Day of April in the Year of Our Lord One Thousand Seven Hundred and Seventy-seven, and in the First Year of the Independence of the said State: Being the first session of this Assembly," Richard Caswell, Esq., being Governor, a law was passed to prevent burning the woods.

This law, here quoted in full from The State Records of North Carolina, vol. 24, has remained in force up to the present year with the exception of those changes made necessary by the freeing of the slaves and by the passing of the whipping-post. This latter institution might even yet be found an effective method of dealing with "vagrant persons."

THE LAW OF 1777.

AN ACT TO PREVENT BURNING THE WOODS.

I. Whereas the frequent burning of the Woods is found to be destructive to Cattle and Hogs, extremely prejudicial to the Soil, and oftentimes of fatal Consequences to Planters and Farmers, by destroying their Fences and other Improvements: For Prevention of which Evils,

II. *Be it Enacted by the General Assembly of the State of North Carolina, and it is hereby Enacted by the Authority of the same,* That it shall not be lawful for any Person whatsoever to set Fire to any Woods except it be his own Property, and in that Case it shall not be lawful for him to set Fire to his own Woods, without first giving Notice to all Persons owning Lands adjacent to such Wood Lands intended to be fired at least Two Days before the time of setting such Woods on Fire, and also taking effectual Care to extinguish such Fire before it shall reach any vacant or patented Lands, contiguous to or adjacent such Lands so fired.

III. *And be it further Enacted, by the Authority aforesaid,* That every Person offending against this Act shall forfeit and pay the sum of Ten Pounds, to be recovered by Action of Debt, Bill, Plaint or Information, to the Use of the Person who shall sue or prosecute for the same; and shall also be further liable to the Party injured by such unlawful firing of the Woods, for all damages that may accrue therefrom.

IV. *And be it further Enacted, by the Authority aforesaid,* That if any Slave, Free Negro or Mulatto, or vagrant Person, unable to pay the fine aforesaid, shall be convicted of setting fire to any Woods, contrary to the true Meaning of this Act, such Person, on Conviction thereof, shall have and receive on his bare back Thirty Nine Lashes, well laid on, at the Public Whipping-Post.

Hon. Francis D. Winston, in his recent address before the North Carolina Pine Association, in speaking of the work of the North Carolina Forestry Association, emphasized the fact that this law was not enacted for the purpose of protecting the forests, but of preventing injury to live stock ranging in the vast areas of then unowned and unoccupied land. He says:

"Not a word is said about the destruction of timber by fires. A century and a half ago our ancestors were enacting laws against the destruction of hogs in the woods by fires. Today the North Carolina Forestry Association is seeking enactments to protect the woods from the hogs by a general stock law. Our association recognizes that a year's supply of timber on the farm is as necessary as the year's supply of corn and meat. We are seeking to convince the people who own lands that in the place of every tree removed for any cause a new tree should be planted. We have in view the establishment of experimental forestry farms about the State. The North Carolina Geological and Economic Survey is fostering this work."

In 1885 a law forbidding wagoners and other campers to leave their camp-fires without totally extinguishing them was passed. There has been, however, no very general enforcement of either of these laws, though there have been no others covering what we now consider these very serious offenses. These two laws (sections 3346 and 3347, Revisal of 1905) have now largely been incorporated in the new forest fire law, in slightly amended form.

MORE RECENT ATTEMPTS TO SECURE EFFECTIVE LAWS.

In 1909 an effort was made to obtain increased protection for our mountain forests by the passage of a law (chapter 89, Public Laws 1909) which allows "any owner or owners of wooded land situated in North Carolina above contour line 2,000 feet" to apply to the Governor for the establishment of such land as a "State forest." The owners pledge them-

selves to cut the timber conservatively, and to pay annually one-half cent for each acre of such proposed State forest into the county school fund. In return for this the rangers employed by the landowner are to be appointed State forest wardens, with power to arrest without warrant violators of the State laws relating to the care of forests. The owners of the land which is thus proclaimed a State forest must, of course, pay the salary and expenses of their own wardens. This law, which requires a man, in addition to bearing all the costs of fire protection, to pay out half a cent an acre for all the land protected, none of which is used for fire protection, is so manifestly one-sided that no advantage has yet been taken of it, and probably none ever will be. In contrast with this, forest fire protective associations are now being organized in several of the Appalachian States whose maximum annual assessment is only half a cent an acre. For this amount the lands are being successfully protected against fire.

There have been many other attempts, both before and since, to secure more adequate State assistance in the prevention and extinguishment of forest fires. As early as 1887, Hon. Francis D. Winston reminds us, he himself introduced a bill for this purpose into the State Senate, but it did not get out of the committee. At each regular session of the Legislature for the past eight years the State Geological and Economic Survey has proposed and urged the passage of definite legislation to reduce the enormous annual loss by forest fires, but with no definite result. The public demand throughout the State has not been strong enough to overcome the natural reluctance of such a conservative body as the General Assembly to enact restrictive laws.

But year by year, as the annual loss from fires has become better known and appreciated, the demand for protection has become more insistent, until the Legislature of 1915 responded by the enactment of an excellent law, though without appropriation.

A law to meet certain particular cases, where logging was being done on land adjoining city watersheds, was passed two years ago.* Though fairly effective in the cases to which it applies, this law, it is thought, has not yet been invoked. It can probably be effectively enforced, however, in connection with the new forest fire law.

In the following pages the forestry laws of the State are given, each accompanied by comments explaining the objects and operations of the law.

*See page 33.

THE NEW FOREST FIRE LAW.*

AN ACT TO PROTECT THE FORESTS OF THE STATE FROM FIRE.

The General Assembly of North Carolina do enact:

SECTION 1. That the State Geological Board may take such action as it may deem necessary to provide for the prevention and control of forest fires in any and all parts of this State, and it is hereby authorized to enter into an agreement with the Secretary of Agriculture of the United States for the protection of the forested watersheds of streams in this State.

SEC. 2. That the forester of the State Geological and Economic Survey, who shall be called State Forester, and shall be *ex officio* State Forest Warden, may appoint, with the approval of the Geological Board, one township forest warden and one or more district forest wardens in each township of the State in which the amount of forest land and the risks from forest fires shall, in his judgment, make it advisable and necessary.

SEC. 3. The State Forester, as State Forest Warden, shall have supervision of township and district forest wardens, shall instruct them in their duties, issue such regulations and instructions to the township and district forest wardens as he may deem necessary for the purposes of this act, and cause violations of the laws regarding forest fires to be prosecuted.

SEC. 4. Forest wardens shall have charge of measures for controlling forest fires; shall make arrests for violation of forest laws; shall post along highways and in other conspicuous places, copies of the forest fire laws and warnings against fires, which shall be supplied by the State Forester; shall patrol during dry and dangerous seasons under the direction of the State Forester, and shall perform such other acts and duties as shall be considered necessary by the State Forester for the protection of the forests from fire. The township forest warden of the township in which a fire occurs shall within ten days make such a report thereof to the State Forester as may be prescribed by him. The township forest warden of the township in which a fire occurs shall within ten days make such a report thereof to the State Forester as may be prescribed by him. Each district forest warden shall promptly report to township wardens any fire in his district.

SEC. 5. Any person who shall maliciously or willfully destroy, deface, remove, or disfigure any sign, poster, or warning notice, posted by order of the State Forester, under the provisions of this act or any other act which may be passed for the purpose of protecting the forests in this State from fire, shall be guilty of a misdemeanor, and upon conviction shall be punishable by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days.

SEC. 6. Forest wardens shall prevent and extinguish forest fires in their respective townships and enforce all statutes of this State now in force or that hereafter may be enacted for the protection of forests and woodlands from fire, and they shall have control and direction of all persons and apparatus while engaged in extinguishing forest fires. Any forest warden may arrest, without a warrant, any person or persons taken by him in the act of violating any of the said laws for the protection of forests and woodlands, and bring

*Chapter 243, Public Laws 1915. See Press Bull. 147, N. C. Geol. and Econ. Survey.

such person or persons forthwith before a justice of the peace or other officer having jurisdiction, who shall proceed without delay to hear, try, and determine the matter. During a season of drought the State Forester may establish a fire patrol in any township, and in case of fire in or threatening any forest or woodland the township or district forest warden shall attend forthwith and use all necessary means to confine and extinguish such fire. The said forest warden may summon any male resident of the township between the ages of 18 and 45 years to assist in extinguishing fires, and may require the use of horses and other property needed for such purpose; any person so summoned, and who is physically able, who refuses or neglects to assist or to allow the use of horses, wagons, or other material required, shall be liable to a penalty of not less than \$5 nor more than \$50. No action for trespass shall lie against any forest warden or person summoned by him for crossing or working upon lands of another in connection with his duties as forest warden.

SEC. 7. Forest wardens shall receive compensation from the Geological Board at a rate of not to exceed 20 cents per hour for the time actually engaged in the performance of their duties; and reasonable expenses for equipment, transportation, or food supplies incurred in fighting or extinguishing any fire, according to an itemized statement to be rendered the State Forester every month, and approved by him. Forest wardens shall render to the State Forester a statement of the services rendered by the men employed by them or their district wardens, as provided in this act, within one month of the date of service, which said bill shall show in detail the amount and character of the service performed, the exact duration thereof, the name of each person employed, and any other information required by the State Forester. All accounts of the forest wardens must be duly sworn to before a justice of the peace, notary public, or other officer qualified to witness such papers within the county in which the expenses were incurred. If said bill be duly approved by the State Forester, it shall be paid by direction of the Geological Board out of the funds hereinafter provided for.

SEC. 8. If any person shall intentionally set fire to any grass land, brush land, or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and also taking care to watch such fire while burning and taking effectual care to extinguish such fire before it shall reach any lands near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days. This shall not prevent action for damages sustained by the owner of any property from such fires.

SEC. 9. Any wagoner, hunter, camper, or other person who shall kindle a camp-fire or shall authorize another to kindle such fire, unless all combustible material for the space of 10 feet surrounding the place where said fire is kindled has been removed, or shall leave a camp-fire without fully extinguishing it, or who shall accidentally or negligently by the use of any torch, gun, match, or other instrumentality, or in any manner whatever start any fire upon any grass land, brush land, or woodland without fully extinguishing the same, shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days.

SEC. 10. All persons, firms, or corporations who shall burn any tar kiln or pit of charcoal or set fire to or burn any brush, grass, or other material, whereby any property may be endangered or destroyed shall keep and maintain a careful and competent watchman in charge of said kiln, pit, brush, or other material while burning. Any person, firm, or corporation violating the provisions of this section shall be punishable by a fine of not less than \$10 nor more than \$50, or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be *prima facie* evidence of neglect of these provisions.

SEC. 11. For the purposes of this act woodland is taken to include all forest areas, both timber and cut-over land, and all second-growth stands on areas that have at one time been cultivated.

SEC. 12. All laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 13. This act shall be in force from and after its ratification.

Ratified this the 9th day of March, A. D. 1915.

Administration.

By placing the administration of the forest fire law with an already existing office of the State Government the tedious and often difficult task of bringing together a new organization has been obviated. In view of the fact that no appropriation accompanies the new law, this provision is shown to be a wise and statesman-like action. The State Geological and Economic Survey, which unfortunately yet has only a small appropriation for its support, is enabled to spend as much as can be spared of its appropriation for the carrying out of the provisions of the law. In the actual work of fire prevention and extinguishment very little can be done without an appropriation, but along other lines the Survey has already taken active steps, chiefly toward informing the public as to what the law is and in what ways it should be observed.

Coöperation.

The latter half of section 1 contemplates a coöperative agreement with the United States Department of Agriculture under the Weeks law, whereby the State can receive very material assistance in the prevention of fires. Section 2 of the Weeks law* reads as follows:

SEC. 2. That the sum of \$200,000 is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, to enable the Secretary of Agriculture to coöperate with any State or group of States, when requested to do so, in the protection from fire of the forested watersheds of navigable streams; and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any State or group of States to coöperate in the

*36 Stat., 961. See Press Bul. 147, Appendix.

organization and maintenance of a system of fire protection on any private or State forest lands within such State or States and situated upon the watershed of a navigable river: *Provided*, that no such stipulation or agreement shall be made with any State which has not provided by law for a system of forest fire protection: *Provided further*, that in no case shall the amount expended in any State exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year.

As no appropriation is made by the State for fire protection, this law can be invoked at present only to a very limited extent. Under the rulings of the United States Forest Service the legal regular apportionment of State moneys paid out for fire preventive measures can be counted in the same way as a direct appropriation. The State Geologist has recently arranged for an expenditure of \$2,000 per year for the next ten years for this purpose. As a result of this arrangement, an annual apportionment of Federal funds up to the same amount has been secured; to be used, according to the ruling of the United States Department of Agriculture, for patrol and lookout work on forests covering the headwaters of streams in the western part of the State.

In addition to this, there are now being advanced tentative plans for a scheme of coöperation with county and township governments, or with groups of private landowners, whereby they may be able to obtain the benefits of the new law without any large State expenditure.

Appointment of Forest Wardens.

The township and district forest wardens, whose appointment by the State Forester is permitted under section 2, should be men of known fitness for the work which they are to undertake. They should be residents of the county and township in which they are to work, should be familiar with all parts of their district, should be men used to the woods, experienced in fighting fires, on good terms with their neighbors, strong, healthy, absolutely honest, and able to make out intelligently such few reports as will be required of them. Where such men are willing to devote a part of their time to the service of the State, receiving only such compensation as is provided in the law, the number of fires will undoubtedly be greatly reduced, as has been the experience under similar conditions in many other States.

It is not proposed to appoint wardens in every township or county in the State, because in many their services are not required, the small areas of woodland and the attitude of the public against forest fires making the services of a forest warden unnecessary. During the past six years in which figures on forest fires have been collected the greatest

part of the destruction has occurred in the mountain and coastal plain counties. These counties would, therefore, require the larger number of forest wardens. Many of the piedmont counties, however, have suffered considerably from fires, and where this has been the case, and the people are willing and anxious to coöperate in trying to prevent fires, the appointment of wardens would probably be made. As a general proposition, it may be stated that in townships containing less than 60 per cent of forest land forest wardens would not be needed, while in those having more than this proportion wooded a considerable number of them might be expected to need wardens.

Even when an appropriation is made by the State for the carrying out of this part of the law no indiscriminate appointment of wardens will be made. Each township will be considered upon its own merits, and only after careful consideration of local conditions and public sentiment, as well as of the fitness of the man proposed, will an appointment be made.

Prosecutions.

The object of this law is not the persecution of private citizens, but the prevention of forest fires. The majority of fires are caused by carelessness, and in most localities these can be gradually lessened by bringing before the people various kinds of reminders to be careful. When carelessness becomes gross or criminal a prosecution is often the only reminder that will have any effect.

But some fires are started intentionally, in plain violation of law. In such cases it is the evident duty not only of the law officers, but of every law-abiding citizen, to do everything possible to bring the offender to justice.

Though the enforcement of the forestry laws is the special duty of the forest wardens for whose appointment provision is made in the new law, prosecutions can also be taken up in the ordinary way. In fact, over the greater part of the State law enforcement will have to come through the regular county and township officers.

Where evidence is obtainable, any citizen or officer of the law can swear out a warrant before a justice of the peace which will be immediately executed by the law officer. The offender will then be tried in the magistrate's court, following the usual procedure. Should a sheriff, deputy sheriff, or township constable discover some one in the act of violating the law, he should arrest him without warrant, take him immediately before a justice of the peace, where the necessary papers would be made out and the trial proceed with the arresting officer as witness.

Forest wardens have the same power as constables and sheriffs to arrest without warrant those taken in the act of violating the forestry laws. In all other cases they must swear out warrants before a magistrate, just as a private citizen would be required to do. They cannot serve a warrant, but it must be turned over to the constable and served in the regular way.

It will, however, be the special duty of the forest warden to work up evidence against all persons suspected of violating the forestry laws. His knowledge of the region and of the people of the region will give the warden a great advantage in this respect. He should be able to find out the cause of a fire without delay, and it is his duty to do so. He must then secure sufficient evidence, swear out a warrant, and, if necessary, appear himself as a witness in the case. Forest wardens are appointed to protect the forests of the State from fire, and this they must do to the utmost of their ability, carrying out the laws enacted for that purpose.

Forest Wardens.

The regulations and instructions contemplated in section 3 will cover such duties as are not specifically mentioned in the law. Included in them would be the manner of procedure in case of fire; instructions as to the best methods of fighting fires in various cases; the organization of a fire-fighting force; the necessary preparations for a fire season; the time when patrol must be undertaken; methods of investigation into the causes of fires; the collection of evidence for prosecutions; and many other things in regard to the daily duties of the wardens.

The duties of fire wardens mentioned in section 4 are those which are universally recognized as the usual duties of such officers. Other duties and acts may be necessary in certain cases, or as conditions which are not now foreseen arise from year to year. These other duties will be such as any employer of help might require of those under him, and will of course be in strict accordance with this and all other laws of the State.

The reports required from forest wardens are necessary not only that the State Forester may be in close touch with the wardens and with fire conditions in the various districts, but also as a check on the monthly accounts sent in by the wardens, which have to be paid after approval by the State Forester. The reports will be as simple and brief as is consistent with the information desired. Blank forms will be printed, so that only a small amount of writing will be necessary. These reports will form the basis of the annual report of the State Forest Warden

as to the number of fires, the area burnt over, the damage done, and the cost to the State in preventing and extinguishing fires. In districts where wardens are appointed these reports will supersede the voluntary reports now sent in in regard to forest fires.

Patrol.

Patrol is an important duty of the forest warden. Patrol means prevention, for usually the officer who patrols prevents as many fires as he extinguishes. By traversing the forests under his charge during excessively dry weather, the patrolman is often not only able to detect and extinguish fires before they get beyond control, but the likelihood of his presence at any place will in all probability deter many who might otherwise either carelessly, negligently, or intentionally start fires. Patrol is such an important part of modern forest fire prevention that the Federal Government stipulates that the money expended by it in coöperative fire protection with the various States must be spent to a large extent in the employment of patrolmen and lookouts.

Patrol is now practiced wherever effective fire protection is attempted. The new State law requires the forest wardens to patrol during dry and dangerous seasons, and, in addition, gives the State Forester full power to establish and direct such patrol whenever in his judgment this is advisable or necessary. By referring to Table 1 it will be seen the "dry and dangerous seasons" are most likely to occur in spring and fall, and it is in these two seasons that most of the patrol work would be carried on. However, local conditions or exceptional seasons might make it necessary to establish patrols at any time of the year.

By virtue of a coöperative agreement recently (June 9, 1915) entered into between the State Geological Board and the United States Department of Agriculture, a number of patrols will be established in the mountainous parts of the State during the fall fire season of 1915, and each fire season thereafter, as long as the arrangement continues. These men will be State Forest Wardens. They will work under the direction of the State Forester, but will be paid by the United States Government. Honest, energetic, intelligent men are required for this work; men who are familiar with the region which they will have to patrol, who have done woods work and have had experience in fighting fire.

The Power of Arrest.

No law can be effective unless it is enforced. The great weakness of the old law against burning the woods was that there was no special system of enforcement. The present law provides that system, and it must be made as effective as possible.

It is well known that many of our worst fires are of incendiary origin. They are started by irresponsible and often vicious men, who are determined to injure their neighbors, or even one particular neighbor, or else are indifferent to the loss sustained by property owners and the community at large. Experience has shown that it is usually very difficult to apprehend such offenders, because they operate in wild, uninhabited country, and often at night. It would be folly to employ men to prevent forest fires, require them to find out who started the fires, and then, when they come up with the offender, compel them to return many miles for the purpose of securing a warrant for the arrest of such offender. It is difficult enough to find the man who burns the woods, but it would be next to impossible to make arrests if such a procedure were required. It has, therefore, always been found necessary to give forest wardens the power of deputy sheriffs, namely, the power to arrest without a warrant those caught in the act of violating the law. This power is not likely to be abused, for it is the policy of the forest warden service to maintain the closest relations of fairness and good-will with all the law-abiding citizens of the district. A forest warden who presumed to misuse his power in this direction would at once be complained of so bitterly that his removal would be accomplished without delay. The whole object of the present law is to prevent and extinguish forest fires, and all other motives must and will be strictly excluded from the operations of the law.

Assistance in Fighting Fires.

The power to summons necessary assistance for fighting fires is given to forest wardens and a small penalty provided for refusal to serve. This means that unless some reasonable excuse can be given for declining to assist in extinguishing fires the persons summoned will be liable to a fine. If a reasonable excuse should be given, and the forest warden should decline to accept such excuse—a contingency hardly likely to occur—the justice of the peace before whom any action would come would undoubtedly decide that such excuse was valid and that the warden was not justified in declining to accept it. This adequately safeguards the power of summons.

Compensation of Forest Wardens.

One of the most frequently advanced arguments against State forest protection has been that by employing men to extinguish fires they were being induced to set out fires in order that they might be reimbursed for extinguishing them. Perhaps the simplest answer to such an argument is that only the worst men in a community would attempt such a

practice, and that the forestry law contemplates the employment of the best men in the community. It would be a poor policy indeed for any forest warden to attempt such a practice, because there are always a large number of people ready to report any failure in duty of a State employee. It is certain that any forest officer who attempted such a thing would get dismissed without delay. On the other hand, should some irresponsible party attempt to practice firing the woods in order to secure employment under the forest warden, the warden would be quick to suspect and discover any such criminal practice. Where such laws are enforced there has been little or no trouble from this source, though the same argument has been advanced against the operation of a like provision of law in nearly every State where it has been tried.

It has occasionally been urged that it is useless to pay men for fighting fires, because in many communities any number of men could be found in an emergency to fight fires without compensation. It would not only be unfair to the citizens of the community to expect them to carry on this most exhausting work without pay, but it would be exceedingly ineffective and would defeat the object of the law. The function of fire protection is to prevent fires rather than to extinguish them. That is, fires should not be allowed to start; and if they do get started, they must be put out before they become large fires. The first rule for the fire fighter is to get to the fire as soon as possible. A small fire is more easily extinguished and does infinitely less damage than a large fire. Now, only the large fire offers sufficient inducement for the average man to leave his regular work and go out and spend half a day or a whole day fighting to stop its advance. A small fire is apt to be neglected in the usually vain hope that it will burn itself out or some one else will extinguish it. The State cannot afford to risk such haphazard methods.

ADDITIONAL PROTECTION TO CITY WATER SUPPLIES.

The State Geological and Economic Survey has consistently advocated the effective protection from fire of the forested watersheds of cities and towns. It has stood and still stands ready at any time to examine such areas with the object of recommending methods for protecting them from forest fires and consequent contamination.

A number of such examinations have already been made and reports submitted. Two such reports have been published, those for Marion and Asheville.*

Following the suggestions contained in these reports, and especially in a letter written by the State Forester and published in the *Asheville*

*See Biennial Reports of the State Geologist, 1909-10, p. 86, and 1911-12, p. 57.

Gazette-News, as well as in editorial comments by that paper, Senator Weaver of Buncombe drew up and introduced into the General Assembly of 1913 a bill which is now one of our important forestry laws.

THE LAW FOR THE PROTECTION OF CITY WATERSHEDS.

The following law, while only applying to municipal watersheds, has an important and increasing usefulness in this State, because of the recent rapid development of the forested watershed idea:

AN ACT TO PROTECT WATERSHEDS OWNED BY CITIES AND TOWNS
FROM DAMAGE BY FIRE.†

The General Assembly of North Carolina do enact:

SECTION 1. That any person, firm, or corporation owning lands or the standing timber on lands within 400 feet of any watershed held or owned by any city or town, for the purpose of furnishing a city or town water supply, upon cutting or removing the timber, or permitting same to be cut or removed, from lands so within said 400 feet of said watershed, or any part thereof, shall, within three months after cutting, or earlier upon written notice by said city or town, remove or cause to be burned, under proper supervision, all tree-tops, boughs, laps, and other portions of timber not desired to be taken for commercial or other purposes within 400 feet of the boundary line of such part of said watershed as is held or owned by such town or city, so as to leave such space of 400 feet immediately adjoining the boundary lines of such watershed so held or owned free and clear of all such tree-tops, laps, boughs, and other inflammable material caused by or left from cutting such standing timber, so as to prevent the spread of fire from such cut-over area and the consequent damage to such watershed.

SEC. 2. That any such person, firm, or corporation violating the provisions of this act shall be guilty of a misdemeanor.

SEC. 3. That this act shall be in force from and after its ratification.

Ratified this the 6th day of March, A. D. 1913.

Pure water means health. A protected watershed insures unpolluted water. An abundant supply of pure water is the best advertisement a city can have. To secure and maintain such a supply is the best investment a city can make.

Many cities and towns in North Carolina own their own "catchment areas" or watersheds; others secure their water from small streams whose drainage area is owned by private individuals. In both cases the State insists that certain general precautions be taken by the city authorities to prevent pollution of their waters, and monthly inspection patrol is insisted upon for this purpose.

The most obvious and most effective measure to prevent pollution of streams, namely, the protection of the woodlands on their watersheds

†Chapter 56, Public Laws 1913.

from fire, has until very recently received no attention from the State, and only in certain noteworthy instances, particularly those of Asheville and Marion, from the municipal authorities themselves.

A bare, hard soil surface, such as is left by burning the woods, allows the rainfall to collect and run directly to the streams, carrying with it small particles of soil, decaying vegetable or animal matter or other material, often laden with typhoid and other disease germs. If, however, the woods are protected from fire, there will be a good coat of leaves on the ground, held together by grass, weeds, and bushes. This makes an absorbent cover to the soil which acts as a sponge, soaking up the rain as it falls and at the same time keeping the soil soft and permeable so that the rainfall will nearly all of it be soaked into the ground. In this way all impurities are filtered out, and the springs are supplied regularly with clear, pure water.

The movement for more complete control by cities and towns of their water supplies has grown very rapidly in North Carolina. At the 1915 session of the Legislature a number of our mountain towns secured the necessary permission to purchase or enlarge their watersheds, Waynesville, Asheville, Hendersonville, Tryon, and Old Fort being among them. These municipal forests must be protected from fire as well as from other dangerous and deleterious influences. Municipal authorities should see that this law is enforced wherever it is applicable. In addition, they should assist the responsible officers in every possible way in the strict enforcement of the general forest fire law.

Watersheds on which part or all of the land is in private ownership may have to be further protected by the enactment of a law to prohibit parties burning over even their own land. Possibly, however, the State Board of Health has already sufficient power to control this.

LAWS FOR THE CREATION OF STATE FORESTS.

NEED FOR DEMONSTRATION IN FORESTRY.

Two-thirds of the land area of North Carolina is in woods and only one-third is cultivated. The woodland, however, yields a much smaller revenue to its owners than does the cleared land. Why? Is it not, at least in part, because we bestow so little thought and labor on the two-thirds which is in forest? No one will work in the woods unless he gets immediate returns in the form of sawlogs, ties, cordwood, etc. Yet much forethought and labor without direct result is expended on the cultivated land. Is it not worth while to know how such forethought and work can be made to increase the value and yields of two-thirds the total area of the State? How has our State Government set about improving

agriculture in North Carolina? Not only by publishing bulletins, instructive but all too little read; not only by providing for talks at farmers' institutes; it is not even satisfied with providing splendid colleges and high schools where young men can be taught both the theory and practice of agriculture. But our active and progressive Department of Agriculture has purchased seven test farms in different regions of the State, where crop varieties are grown, and where it is shown which varieties and what methods are most suitable for certain soils and climates. In addition to these and in a way combining the college and the test farm, farm-life schools are being established in nearly every county in the State. But the arguments which above all else bring home to the adult farmers the possibility, even the necessity, of practicing better methods are brought out on the demonstration plats maintained by the Department of Agriculture, and the demonstration crops supervised by State and county demonstration agents.

Does not this suggest the value of State experiment and demonstration forests in carrying out a forest policy for the State? The Department of Agriculture has set a precedent which the Forestry Department should not only be allowed, but required to follow.

THE LAW GOVERNING THE ACQUIREMENT AND ADMINISTRATION OF STATE FORESTS.

The following law, passed at the recent session of the Legislature, is the first step in the inauguration of such a policy. While it does not provide funds for the purchase of forest lands, it does recognize the principle of State experiment and demonstration forests, and places the authority to purchase such forests, when money for that purpose may be available, with a responsible and competent department of the State Government. It also provides that State forests may be organized and administered without any further legal enactments, where gifts of land can be secured for this purpose.

AN ACT TO ALLOW THE ACQUIREMENT BY THE STATE OF STATE FORESTS.*

The General Assembly of North Carolina do enact:

SECTION 1. That the Governor of the State is authorized, upon recommendation of the Geological Board, to accept gifts of land to the State, the same to be held, protected, and administered by said board as State forests, and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be absolute except in such cases as where the mineral interest on the land has previously been sold. The State Geological Board shall have the power to purchase lands in the name of the State, suitable chiefly for the production of timber, as State

*Chapter 253, Public Laws 1915.

forests, for experimental, demonstration, educational, park, and protection purposes, using for such purposes any special appropriations or funds available. The Attorney-General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made. Said State forests shall be subject to county taxes assessed on the same basis as are private lands, to be paid out of moneys in the State Treasury not otherwise appropriated.

SEC. 2. That all moneys received from the sale of wood, timber, minerals, or other products from the State forests shall be paid into the State Treasury and to the credit of the Geological Board; and such moneys shall be expended in carrying out the purposes of this act and of forestry in general, under the direction of the Geological Board.

SEC. 2½. That nothing in this act shall operate or be construed as authority for the payment of any money out of the State Treasury for the purchase of lands or for other purposes unless by appropriation for said purpose by the General Assembly.

SEC. 3. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 4. That this act shall be in force from and after its ratification.

Ratified this the 9th day of March, A. D. 1915.

Though this is a new departure for North Carolina, it is by no means a new idea, as State experiment and demonstration forests have been consistently advocated by the North Carolina Geological and Economic Survey for a number of years (see Economic Paper No. 22, p. 42; Press Bulletins Nos. 130, 142, 145). A number of States to the north and west of us are now operating such forests. The Forestry Committee of the Fifth National Conservation Congress reported two years ago a total of sixty-three State forest experiment stations in eleven States, more than three-quarters of them being in the two States of Pennsylvania and Ohio. In some cases regular State forests, or parts of them, are used as experiment forests, while in other cases separate and smaller areas are procured. Ohio, for example, has fourteen experiment forests and no State forests, while Michigan has fifty-two State forests and only one experiment forest. However, all organized and administered State forests cannot help but be demonstration forests to a greater or less extent, because they show to the citizens how the State manages its own forest lands. Whether these are managed in the right or wrong way depends on the knowledge and money available, and the knowledge depends, at least in part, on experiments which should be made on those or similar forest areas.

Gifts of Land for State Forests.

There are, no doubt, many public-spirited citizens of North Carolina who, if they realized the need for demonstration and experiment forests,

would gladly give to the State enough forest land to adequately serve such a purpose. Not only is low-priced land suitable for this purpose, but valuable land is most unsuitable. Agricultural land is not wanted, though a small percentage of such might be included in the place. What is needed is to show how forest which is to remain in woods should be managed. There is land in nearly every county which will pay better to keep in woods than to clear. This is certainly worth less to the owner than the average land in the neighborhood. At the same time it would suit forest demonstration purposes better, because it is absolute forest land, *i. e.*, land which should remain permanently in woods.

Demonstration forests, however, should be accessible. As their chief use is to show by actual practice what can be done in forestry, they should be where as large a number of people as possible can see them; for instance, near a main line of railway or on an improved and well traveled highway.

Again, they must contain fairly average samples of at least one important type of forest of the region, and if possible all the important types should be represented. For instance, a demonstration forest in the eastern piedmont region should have some hardwood and pine forest, some old-field pine, and some pure hardwood forest, with a fair representation of most of the important timber trees of the region.

Purchasing State Forests.

The above law provides for two other methods of securing State forests besides by gift. The State Geological Board is allowed to purchase State forests either with money specially appropriated by the General Assembly for the purpose or with other funds which may be available. Section 2½ is designed to make clearer the purpose of this provision. It says that money cannot be withdrawn from the State Treasury for the purchase of land without special appropriation by the Legislature. However, when such appropriation is made the Geological Board cannot only purchase land, but it can administer it as a State forest; protect it from fire and trespass; do necessary cutting and thinning; plant trees or sow seed; dispose of surplus timber or other products, and make experiments in improved forest management.

Specific instructions as to the management and care of such land are not necessary in bills appropriating money to buy State forests, because general permission to properly administer them is given by this present law.

The State Geological Board is also allowed to purchase State forests "for experimental, demonstration, educational, park, and protection purposes," using any funds available. There is not likely to be very much

of the regular appropriation for the work of the Board available, but the Board is able to accept subscriptions or donations of money from private individuals or organizations for the purpose of buying State forests. In fact, this is clearly contemplated by law. A State forest of a few hundred or even thousand acres would be a worthy monument to any individual or event. Why should not one or more of North Carolina's patriotic and public-spirited organizations take the lead in a movement to accumulate funds for such a purpose? Will not Mount Mitchell State Park be a nobler and more enduring monument to Dr. Elisha Mitchell than any one which could be erected to him in metal or stone? There is room in this State for a number of such monuments, and the permanent benefit from their establishment would be incalculable.

SOME PROBLEMS TO BE SOLVED.

Some idea of the variety of questions which can be solved most satisfactorily by the State or National Governments can be gathered from the following quotation from Press Bulletin 142, "Demonstration Forests for North Carolina," North Carolina Geological and Economic Survey:

There are five principal forest regions in North Carolina, (1) The Spruce, (2) Mountain Hardwoods, (3) Piedmont Region, (4) Coastal Plain, (5) The Banks. Some of these can well be divided again into smaller subdivisions.

(1) The Spruce forests on the slopes of our highest mountains are of the greatest importance in regulating stream flow and for park purposes. Lumbering operations as at present practiced result in their total destruction. It will pay the State to demonstrate that lumbering can be done in these forests without such devastating waste. A State forest in this type could at the same time be used as a State park, and for the protection of the important mountain streams.

(2) The Mountain forests, which now contain the greater part of our old-growth hardwood supply, are being cut in such a way that the more valuable kinds of timber trees are rapidly disappearing. Landowners should be shown how to cut so that the proportion of the poplar, chestnut, linn, and other valuable species will be increased in the second growth, rather than diminished.

(3) The original growth pine has been so largely removed from what were the mixed hardwood and pine forests of the Piedmont region that the second growth now consists almost entirely of the much slower growing oak. How best to increase the proportion of young pine timber in these woods is a problem which can be decided by experiment, and can then be conclusively shown by demonstration.

(4) The rehabilitation of our once large turpentine industry depends on second-growth long-leaf pine. This tree has been practically exterminated over large areas, and little effort is being made to bring it back, even in the districts best suited to its growth. Experiments on the ground would show that much so-called waste land could profitably produce long-leaf pine.

(5) "The Banks" and similar areas along our coast were originally covered with forests. Now they are mostly bare sandy wastes. The best methods of reforesting them and making them permanently productive, and at the same time stopping the ceaseless drifting of the sand, can only be shown by doing actual work in reforestation on the ground.

These and many other just as important problems in forest management and forest protection have to be solved to the satisfaction of the people of North Carolina, and *this can best be done by the State on State-owned forest land.*

FURTHER BENEFITS OF STATE FORESTS.

While the most important use of State forests is their educational value through demonstration and experimentation, they have several other uses, any of which in itself is generally considered sufficient excuse for their creation, and, added to the primary object, double their value to the State.

(a) *Protection Forests.* A forest covering a city watershed or lying on the headwaters of a stream or on a steep mountain slope serves as a protection against muddy or polluted water or against floods and extreme low water. Such forests should be publicly owned and controlled by the Nation, State, or municipality as protection forests. Asheville, Marion, and other of our towns own such forests, and the Federal Government is purchasing the Appalachian National Forests with this object primarily in view. All the spruce and balsam forests in North Carolina should be publicly owned, if only for this one reason.

(b) *Park Forests.* There are areas in all States which are noted for their scenery, extensive views, grand waterfalls, beautiful trees, rugged cliffs or gorges. The forest forms such an integral part of the attractiveness of such places that their value would be destroyed by its removal. Such natural monuments seem to belong by right to the whole people, and they should be preserved intact. Even though now in private ownership, they should be acquired and preserved by the State for the pleasure, health, and recreation of its citizens and for generations yet to come, all of whom have an actual interest in their perpetuation.

MOUNT MITCHELL STATE PARK.

It was primarily for the two above reasons, as set forth in its preamble, that the General Assembly passed the bill to purchase the top of Mount Mitchell as a State park. This project has been strongly advocated by the North Carolina Forestry Association and has been consistently urged by the State Geological and Economic Survey. (See Press Bulletins Nos. 100, 119, 135, and 138.) The measure was ably championed by Governor Craig and was indorsed by the Asheville Board of Trade and many other similar bodies. The bill was introduced into the General Assembly by Senator Zebulon Weaver of Buncombe, who, two years earlier, had proposed a similar measure. It received the strong support of a number of influential men in both houses of the Legislature, and was passed in the House by a majority of 67 to 32.

THE MOUNT MITCHELL PARK PURCHASE LAW.

The following is a copy of the law authorizing the purchase of the summit of Mount Mitchell:

AN ACT TO APPOINT A COMMISSION TO ACQUIRE A PORTION OF MOUNT MITCHELL, INCLUDING THE SUMMIT, AND TO PROVIDE FOR THE CREATION OF A PUBLIC PARK FOR THE USE OF THE PEOPLE OF THE STATE OF NORTH CAROLINA.*

Whereas the summit of Mount Mitchell in Yancey County is the greatest altitude east of the Rocky Mountains; and whereas the headwaters of many of the important streams of the State are at or near the said summit, and the forest is being cleared, which tends to damage and injure the streams flowing through the said State from the mountains to the Atlantic Ocean; and whereas it is deemed desirable that this beautiful and elevated spot shall be acquired and permanently dedicated as a State park for the use of the people of the entire State seeking health and recreation; and whereas, unless the said land is acquired by the State at this time, the cost of acquiring it at a later date will be greatly increased and the water-courses may be damaged and the beauty of the scenery destroyed by removing the growth therefrom, and irreparable damage accrue: Now, therefore,

The General Assembly of North Carolina do enact:

SECTION 1. That a commission is hereby created, to consist of five practical business men who shall be appointed by the Governor, and which shall carry out the provisions of this act and shall be known as the "Mitchell Peak Park Commission."

SEC. 2. That said commission shall be and is hereby created a body politic and corporate under the name and style of the "Mitchell Peak Park Commission."

SEC. 3. That the said commission shall have the power to fix the time and place of its meeting. Said commissioners shall hold office until the property hereinafter described shall have been purchased and a deed made to the State of North Carolina and until they shall have made a report of the same to the General Assembly and shall have been discharged. In the event of the death or resignation of any member of said commission, his successor shall be appointed by the Governor. The said commissioners shall receive no compensation but their traveling expenses, including hotel bills, while actively engaged in the work of said commission, and these expenses shall be paid out of the funds hereinafter provided for: *Provided*, that the said commission shall under no circumstances expend or contract to expend a greater amount than that named in this act for the purchase of said land.

SEC. 4. The said commission shall convene as soon as practicable and elect a chairman. The said chairman shall from time to time draw a warrant or warrants upon the treasurer of the State, which, after being approved and countersigned by the Governor and two other members of the commission be-

*Chapter 76, Public Laws 1915.

sides the chairman, shall be paid by the said treasurer to the owner of said lands purchased for the said purpose out of any funds not otherwise appropriated.

SEC. 5. The total amount to be expended under this act shall not exceed \$20,000, and the said sum of \$20,000 is hereby designated as a maximum amount to be expended in the acquisition of the said properties, and the said commission is especially charged with the duty of acquiring as much of the lands as is possible for the purpose intended, not exceeding the maximum amount hereinbefore designated.

SEC. 6. Out of the funds so appropriated the said Mitchell Peak Park Commission shall have power, as soon as practicable, to acquire either by purchase or condemnation so much of Mount Mitchell, including the peak thereof, as they shall deem necessary as a suitable site for the purpose intended, and in the event of the purchase of said land or lands privately from the owner or owners thereof, the said commission shall take a deed to the State of North Carolina therefor.

SEC. 7. Whenever from any cause the said commission cannot agree with the owner or owners of the land which they shall select for the purpose of the park as aforesaid, as to the price to be paid for the same or for any part thereof, said land or lands may be taken at a valuation to be made by three competent and disinterested freeholders of the county of Yancey, one of whom, after due notice to the landowner of such proceedings, shall be chosen by the said commission, one selected by the landowner, and these two shall select a third; and in case the landowner refuses to select, then said commission shall select two and these two shall select a third, and said freeholders after being duly sworn by a justice of the peace of the county of Yancey, shall at once go on said land and proceed to condemn said land or lands and ascertain the sum which shall be paid the owner or owners of said properties and report the same to the said commission, under their hands and seals, which report, on being confirmed by the said commission and spread upon their minutes, shall have the effect of a judgment against the said Mitchell Peak Park Commission, and upon paying said sum to the landowner, or in the event of an appeal, upon paying said sum to the chairman of said commission to await the result of such appeal, shall pass title to the State of North Carolina of the land so taken: *Provided*, that if any person whose land is taken for the said purpose or the said commission be dissatisfied with the valuation thus made, then and in that case either party may appeal to the next term of the Superior Court of Yancey County within ten days from the filing of such report: *Provided further*, that such appeal shall not hinder the commission from taking possession of said property.

SEC. 8. The Governor shall have power, upon complaint or upon his own motion, to remove any of said commissioners for negligence of duty or for any conduct unbecoming said commissioner and inconsistent with his duties under this act. The position of commissioner under this act shall not be construed to be an office within the meaning of section 7, Article XIV of the Constitution of North Carolina. The said Mitchell Peak Park Commission shall make report to the Governor, setting forth all purchases, condemnations, and expenditures of every kind under this act.

SEC. 9. This act shall be in force from and after its ratification.

Ratified this the 3d day of March, A. D. 1915.

Fire Protection Needed.

It will be seen that this bill provides only for the purchase of the land. Its weakness seems to be that no provision is made for the protection of the land from fire both during and subsequent to its acquisition. Since logging operations commenced two years ago, the forest areas which it is planned to buy have been constantly threatened with destruction, and several times fire has come upon the southern slope of the mountain. Fires at any time are liable to destroy hundreds of acres of these spruce forests, and, once destroyed, the beauties of the park would be gone. There is immediate need for some adequate system of fire protection for the Mount Mitchell State Park. Fortunately, special arrangements are now under consideration, and it is hoped that before fall effective protection can be given at least the part of this mountain which is to be purchased by the State. It would be most appropriate that the very first State protection furnished by North Carolina should be given to historic Mount Mitchell.

The Commission.

The Mitchell Peak Park Commission provided for by this law was appointed by the Governor on March 31. It consists of the following gentlemen, all of them from regions vitally concerned in the purchase of the park, and all but one from Yancey, the county in which Mount Mitchell is situated:

- Mr. T. E. Blackstock, Asheville, N. C.
- Mr. G. P. Deyton, Green Mountain, N. C.
- Mr. E. F. Watson, Burnsville, N. C.
- Mr. M. C. Honeycutt, Burnsville, N. C.
- Mr. Wilson Hensley, Bald Creek, N. C.

This commission met in Burnsville Saturday, April 10th, and organized by electing Mr. T. E. Blackstock chairman and Mr. M. C. Honeycutt secretary. A second meeting was planned to take place in May on the top of Mount Mitchell, with the object of securing local information in regard to the different properties which are being considered for purchase under the law.

APPALACHIAN NATIONAL FORESTS.

The Federal Government cannot purchase or acquire control of land in any State without the permission of that State. It was therefore necessary, when the people were asking that National forests or parks be established in western North Carolina, that the State grant the Government the right to make such purchases. The following law was

passed by the General Assembly of 1901, at the beginning of the agitation for the Appalachian Park and just ten years before the Federal law taking advantage of this permission was finally enacted. (See Press Bulletin 147, Forestry Laws of North Carolina, Appendix.)

LAW TO ALLOW FEDERAL ACQUIREMENT.

5430. *Forest reserve, western Carolina.* *The United States is authorized to acquire by purchase, or by condemnation with adequate compensation, except as hereinafter provided, such lands in western North Carolina as in the opinion of the Federal Government may be needed for the establishment of a National Forest Reserve in that region. This consent is given upon condition that the State of North Carolina shall retain a concurrent jurisdiction with the United States in and over such lands so far that civil process in all cases, and such criminal process as may issue under the authority of the State of North Carolina against any person charged with the commission of any crime without or within said jurisdiction, may be executed thereon in like manner as if this consent had not been given. Power is hereby conferred upon the Congress of the United States to pass such laws as it may deem necessary to the acquisition as hereinbefore provided, for incorporation in such National forest reserve such forest-covered lands lying in western North Carolina as in the opinion of the Federal Government may be needed for this purpose, but as much as 200 acres of any tract of land occupied as a home by *bona fide* residents in this State on the 18th day of January, 1901, shall be exempt from the provisions of this section. Power is hereby conferred upon Congress to pass such laws and to make or provide for the making of such rules and regulations, of both civil and criminal nature, and to provide punishment therefor, as in its judgment may be necessary for the management, control, and protection of such lands as may be from time to time acquired by the United States under the provisions of this section.

Acquirement by Purchase Only.

In a few localities in western North Carolina considerable opposition to the National Forest Reserve policy was at one time developed, based largely on a misunderstanding of the conditions on which the land was to be procured. The above State law allows the United States to acquire land "by purchase, or by condemnation with adequate compensation." From this permission the idea gained ground that the Government would condemn land and take it whether the owner wished to sell it or not. This is permitted under the State law, provided "adequate compensation" is made. But the Federal law under which Appalachian forest lands are acquired stipulated "that the Secretary of Agriculture is hereby authorized to *purchase*," and no other method of securing these lands is mentioned in the whole law. There has been no thought

*Chapter 118, section 5430, Revisal 1905.

of employing condemnation proceedings such as are allowed by the State law and as are actually to be put in practice by the Mitchell Peak Park Commission,‡ if it is found necessary to do so.

It is true, that in order to secure a clear title to land which is owned by a number of different claimants who have not only expressed a willingness to sell, but have agreed upon a price, the Government has in certain cases brought condemnation proceedings in court. These are nothing but friendly suits to determine the real ownership of the lands and the proper share of the price each claimant is entitled to. It is a proceeding all business men are familiar with, and can be objected to by no one.

It will be noticed that in all dealings with the Federal Government the rights and privileges of the State are jealously guarded. Not only does the State Legislature clearly define the powers which it delegates to the United States, but Congress clearly stipulates in the law allowing the purchase of land that no land shall be bought in any State which has not previously given its consent thereto.‡

PROTECTION OF GAME ON NATIONAL FORESTS.

It is with the same scrupulous care to maintain the most cordial relations with the State of North Carolina and avoid any possible cause of friction that permission was asked by the Federal Government to make and enforce regulations for the protection of animal life on the Appalachian National Forests. It might seem that such power was conferred upon Congress by the law allowing the United States to buy lands (page 43), but this was not considered specific enough. In accordance, therefore, with its policy, the Government of the United States asked permission to make such rules and regulations as were thought needful "in respect to game animals, game and nongame birds and fish" on Federal lands in the western part of North Carolina.

LAW TO ALLOW FEDERAL PROTECTION OF WILD LIFE.

The permission requested by the Federal Government was granted by the General Assembly of 1915 in the following law:

‡See page 41.

AN ACT TO GIVE THE CONSENT OF THE STATE OF NORTH CAROLINA TO THE MAKING BY THE CONGRESS OF THE UNITED STATES, OR UNDER ITS AUTHORITY, OF ALL SUCH RULES AND REGULATIONS AS IN THE OPINION OF THE FEDERAL GOVERNMENT MAY BE NEEDFUL IN RESPECT TO GAME ANIMALS, GAME AND NONGAME BIRDS, AND FISH ON LANDS, AND IN OR ON THE WATERS THEREON, ACQUIRED OR TO BE ACQUIRED BY THE FEDERAL GOVERNMENT IN THE WESTERN PART OF NORTH CAROLINA FOR THE CONSERVATION OF THE NAVIGABILITY OF NAVIGABLE RIVERS.*

Whereas the Government of the United States, with the consent of the General Assembly of the State of North Carolina, has acquired and will acquire areas of forested land in the western part of said State for the purpose of conserving the navigability of navigable streams, and said lands and waters thereon are and will be stocked, naturally and artificially, with game animals, game and nongame birds, and fish; and whereas, in order adequately to enjoy and protect the occupancy and use of said areas, it is important that the United States be fully authorized to make all needful rules and regulations in respect to such animals, birds, and fish: Therefore,

The General Assembly of North Carolina do enact:

SECTION 1. That the consent of the General Assembly of North Carolina be and hereby is given to the making by the Congress of the United States, or under its authority, of all such rules and regulations as the Federal Government shall determine to be needful in respect to game animals, game and nongame birds, and fish, on such lands in the western part of North Carolina as shall have been or may hereafter be purchased by the United States under the terms of the act of Congress of March 1, 1911, entitled "An act to enable any State to coöperate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purposes of conserving the navigability of navigable rivers" (36 United States Statutes at Large, page 961), and acts of Congress supplementary thereto and amendatory thereof, and in or on the waters thereon.

Ratified this the 9th day of March, A. D. 1915.

The people of North Carolina are coming to realize very acutely that our wild life needs protection quite as much as any other of our natural resources. The destruction of the food fishes of our streams by unrestrained and often unlawful fishing and by polluting the waters with sawdust or mill waste has reached alarming proportions. And when we come to think of it, what right has a man to deprive a neighborhood of one of the most delicious and healthful of foods in order that he may have 5 cents more per thousand feet of lumber on his sawing or a fraction of a cent more profit on his investment in some large manufacturing plant? The manufacturers of lumber, of leather, of paper, all do their

*Chapter 205, Public Laws 1915.

part towards the development of the community and the State, but we are beginning to realize that in prosecuting their business they have no right to trespass upon the rights of their neighbors.

Game birds in North Carolina have generally been looked upon in the light of the special property of the sportsman, and heretofore game laws have been passed chiefly for his benefit. We are now, however, coming to realize that the farmer, the owner of the land, has much more interest in the game which lives upon his land than has the man whose sole interest is killing it. To mention one instance of this, our common partridge or quail is worth to the farmer for destroying noxious insects a great deal more than it is to the sportsman or the hotel keeper. In the future our game laws must consider, first, the value of the living birds and animals to the landowner and the general public before it considers their value from the old standpoint of being something to kill.

ARBOR DAY.

The regular observance of Arbor Day in North Carolina has been strongly advocated by the State Geological and Economic Survey for a number of years. The first press bulletin on this subject ever issued by the Survey had the above title, and not only advocated the general observance of this day throughout the State, but suggested the adaptation of a program to the special conditions existing in North Carolina. As well as emphasizing the planting of trees, it was recommended that the attention of the children be called to the value of the forests of the State to the life of the average citizen. In the words of the author of the press bulletin above referred to, which was issued April 7, 1908, "It is to be desired that this day shall be more generally observed and that our young people shall be brought to a realization of the value of our forests and the beauty and need of trees for shade and decorative purposes. . . . How soon many of our school yards could be made places of beauty if on each Arbor Day the school would plant a certain number of trees or shrubs and then care for them during the year.

"While the same reasons for the observance of Arbor Day in the scantily forested western States cannot all hold in a well wooded State like North Carolina, yet the celebration here of such a day has its significance. Arbor Day in North Carolina could be set aside for the school children to learn of the great natural gift which we have in the forests, and the relation of the forest to the well-being and wealth of our people."

ARBOR DAY LAW.

An Arbor Day law such as is found on the statute books of practically half the States of the Union was introduced into the General Assembly

of 1913. It, however, failed of passage, owing to the rush of bills at the end of the session. A similar bill was introduced into the Legislature of 1915, and, backed by the good people of Charlotte (who had previously held a most successful Arbor Day celebration in that city), by the North Carolina Forestry Association, the State Geological and Economic Survey, and others interested in Forestry, it became a law without any serious opposition.

AN ACT TO APPOINT AN ARBOR DAY FOR NORTH CAROLINA.*

The General Assembly of North Carolina do enact:

SECTION 1. That the Friday following the first day of November in each year shall be known as Arbor Day, to be appropriately observed by the public schools of the State.

SEC. 2. That the Governor is herewith authorized to make proclamation setting forth the provisions of this act and recommending that Arbor Day be appropriately observed by the school children of the State, in order that they may be brought up to appreciate the true value of trees and forests to their State.

SEC. 3. That it shall be the duty of the State Superintendent of Public Instruction to take the matter of the observance of Arbor Day by the public schools of the State under his general supervision, to issue each year a program for its observance, to cover such part of the day as he may prescribe, and to transmit suitable instructions to the county school authorities under his charge for an appropriate observance of Arbor Day.

SEC. 4. That this act shall be in force from and after its ratification.

Ratified this the 25th day of February, A. D. 1915.

At first thought, it would seem that Arbor Day should be celebrated in the spring. The planting of trees and shrubs and the general call of the out-of-doors appeals to children much more strongly in the spring than in the fall. Many kinds of trees do better planted just before the sap starts in the spring than if planted in the autumn. It is for these and other reasons that most States keep Arbor Day in the spring, endeavoring to select a date upon which planting would be most likely to be successful. In many of the Southern States, however, the public schools are not in session in the spring; so that it is impossible to have the day generally observed by the schools at that time of the year. It is for this reason that several States observe Arbor Day in the fall. Two or three have two Arbor Days a year, one in the spring and one in the autumn. Kentucky, which originally appointed a spring day, has found it necessary to change to November.

For this same reason it was thought advisable, after consultation with the North Carolina school authorities, to fix a day when practically all schools in the State are in session. It is hoped that this will insure

*Chapter 51, Public Laws 1915.

the observance of Arbor Day throughout North Carolina. The selection of Friday as Arbor Day was made by the public school authorities in order that the exercises would break into the regular school curriculum as little as possible.

Manner of Observance.

It is the custom in most States where Arbor Day is observed for the Governor to issue a proclamation calling the attention of the people to the advantages of observing the day with tree planting, decorating school grounds and home grounds, and studying the relation of trees and forests to the life of the people. Governor Craig has expressed his approval of this practice by indorsing this same provision in the North Carolina law. The law expressly authorizes the Governor to make the proclamation, but it does not require it. Whether, therefore, the proclamation is made or not, the validity of the observance will be the same, but the active participation of the Chief Executive in this way would add interest and enthusiasm to the occasion.

The State Superintendent of Public Instruction, who assisted in the preparation of the bill and has, since its passage, expressed his entire agreement with its provisions, will, as provided by the law, issue a program and instruct the school authorities to observe the day in the proper manner. Already several suggestions for Arbor Day celebrations have been published by the various State departments, and these may be referred to for assistance. Two years ago the Department of Education, assisted by the State Geological and Economic Survey, prepared an Arbor Day program and made other suggestions for the observance of the day. (See *Civic Days: Good Roads, Arbor Day*, pages 35-46, Bulletin XXII, N. C. Department of Education, 1913.) Last year the same department issued a program entitled "Community Service Week in North Carolina"; a few suggestions for improving school grounds by planting trees, which can be done on Arbor Day, will be found on pages 16 and 85 of that publication. Other references to Arbor Day observance in North Carolina can be found in Economic Paper No. 22, "Forest Fires and Their Prevention," and Press Bulletin No. 49, "Arbor Day in the North Carolina Schools." Some of the North Carolina towns have also published Arbor Day programs, notably Durham in 1896 and Charlotte in 1913. Many of the States issue annually handsomely illustrated Arbor Day bulletins or hand-books. In these are reprinted poems and other selections which can be recited by the school children.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, 1915. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*

25. Monazite, Zircon, and Other Minerals Used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt. *In press.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of

Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Prof. Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina During 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties, with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a List of Gems and Gem Minerals occurring in United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems occur, as taken from United States Geological Survey Report, by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin, and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos, describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin Mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31 and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey. Statistical Report of High-

way Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of the Seventh Annual Drainage Convention held at Wilson, N. C., November 18 and 19, 1914. Compiled by Joseph Hyde Pratt. *In press.*

42. Proceedings of the Road Institute held at the University of North Carolina February 23-27, 1915. Compiled by Joseph Hyde Pratt. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declinations at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the southeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Caro-

lina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

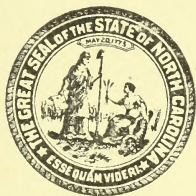
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 41

PROCEEDINGS
OF
SEVENTH ANNUAL DRAINAGE CONVENTION
OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION
HELD AT
WILSON, NORTH CAROLINA
NOVEMBER 18 AND 19, 1914

COMPILED BY
JOSEPH HYDE PRATT, State Geologist
AND
MISS H. M. BERRY, Secretary



RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
STATE PRINTERS
1915

X 53-7
N 813 2

GEOLOGICAL BOARD

GOVERNOR LOCKE CRAIG, <i>ex officio</i> Chairman	Raleigh
FRANK R. HEWITT	Asheville
HUGH MACRAE	Wilmington
HENRY E. FRIES	Winston-Salem
JOHN SPRUNT HILL	Durham

JOSEPH HYDE PRATT, <i>State Geologist</i>	Chapel Hill
---	-------------

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., August 1, 1915.

*To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.*

SIR:—On November 18 and 19, 1914, there was held at Wilson, North Carolina, the Seventh Annual Convention of the North Carolina Drainage Association. Because of the magnitude which the drainage of our swamp and overflowed lands has reached in North Carolina, the value to this work of the papers and discussions given at this convention, and the close coöperation between the North Carolina Geological and Economic Survey and the Drainage Association, I recommend that these proceedings be published as Economic Paper No. 41 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

LIST OF ILLUSTRATIONS

	PAGE
FIG. 1. Ideal grouping of soil grains induced by proper drainage. Note the abundance of pore space for both water and air.....	27
FIG. 2. Massing of soil grains in soil puddled by lack of drainage. Note the small amount of pore space for water and the absence of air	27
FIG. 3. Shallow rooting with poor drainage. Deep rooting with water table lowered	28

CONTENTS

	PAGE
Introduction	7
Proceedings of Seventh Annual Drainage Convention	11
Morning Session, Wednesday, November 18, 1914.....	11
Address of Welcome	11
Secretary's Report	16
Treasurer's Report	16
Afternoon Session, Wednesday, November 18, 1914.....	20
Appointment of Committees	20
The Upbuilding of Eastern Carolina Through Drainage and the Resulting Benefits to the Railroads, by Mr. B. E. Rice, Land and Industrial Agent, Norfolk Southern Railroad.....	21
Tile Drainage, by Mr. W. E. Sherwin, Professor of Soils in the North Carolina College of Agricultural and Mechanic Arts....	24
The Importance of Principles of Farm Drainage, by H. M. Lynde, of the U. S. Department of Agriculture.....	30
Recognizing the Need of Drainage	31
Water in Soils	32
The Open Ditch	32
Underdrains	33
Effects of Drainage Upon the Soil.....	33
Practical Benefits of Drainage	34
Tile Drainage	35
Clay Tile	35
Concrete Tile	35
Arrangement of Drains	36
The Depth and Distance Apart of Drains.....	36
Grade	37
Size of Tile	37
Construction of Tile Drains.....	38
Cost of Tile Drainage	38
Thursday, November 19, Morning Session.....	40
The Drainage and Development of North Carolina's Muck Lands, by C. W. Mengel, Drainage Engineer.....	40
Drainage	41
Development	42
Reports from Representatives of Drainage Districts.....	44
North Carolina Drainage Law and Some Needed Amendments, by Hon. John H. Small, Congressman from First District....	46

	PAGE
Afternoon Session, Thursday, November 19, 1914.....	58
Some New Factors in Drainage Work in North Carolina, by Lawrence Brett, Drainage Engineer	58
Reports of Committees	62
Committee on Resolutions	62
Membership Committee	64
Counties Represented at Convention	64
Report of Legislative Committee	64
Report of Committee on Nominations and Next Meeting Place	66
List of Registered Delegates to the Annual Convention of the North Caro- lina Drainage Association, Held at Wilson, November 18 and 19, 1914..	69
List of Publications of the North Carolina Geological and Economic Sur- vey	71

INTRODUCTION

Since the organization of the North Carolina Drainage Association in 1908, there has been close coöperation between its work and that of the North Carolina Geological and Economic Survey; and it was through the work of these two agencies that the North Carolina drainage law was drafted and passed by the Legislature of 1909 and amended by subsequent Legislatures. It is largely through the conventions of this Association that public opinion has been awakened to the immense importance to the State of the drainage of these wet lands, including both swamp lands of the coastal plain and overflowed lands of the Piedmont and mountain regions.

The work of organizing each convention has been done largely by the Geological Survey and for the Seventh Annual Convention the following letter was prepared and sent to the chairmen of the boards of county commissioners, asking them to appoint delegates to represent their respective counties; to the mayors of towns and cities for the appointment of delegates to represent their municipalities; to the presidents of boards of trade and chambers of commerce to represent their bodies; and to the commissioners of drainage districts already established for the appointment of delegates to represent their individual districts.

CHAPEL HILL, N. C., October 15, 1914.

DEAR SIR:—At Wilson, N. C., on November 18 and 19, 1914, will be held the Seventh Annual Convention of the North Carolina Drainage Association. I am extending to you a most cordial invitation to attend this Convention as a delegate, and will ask you to appoint ten delegates to represent your..... I will appreciate it if you will select men who are sufficiently interested in this work to attend the Convention and to take part in the proceedings. Send me their names and addresses so that they can be officially notified of their appointment. I sincerely hope that it will be possible for you to attend yourself, and that you will urge the delegates whom you appoint to attend.

Enclosed is a circular relating to the Reclamation of the Swamp and Overflowed Lands of the State which shows the work which has been done for drainage since the organization of our Association seven years ago. These data show that the drainage work of the State has assumed large proportions, and is meaning much to our people, not only from an economic standpoint in the reclamation of most valuable agricultural lands, but from the standpoint of health. Vast areas of eastern North Carolina, which, before drainage, were not only worthless, but were a menace to public health, are now yielding large revenues to this section and are being made desirable places for residence through the elimination of the malarial mosquitoes.

The drainage of the creek and river bottoms of Piedmont and western

North Carolina is also assuming large proportions, and is proving of inestimable value to these sections.

Trusting that you will cooperate with us in the appointment of delegates, and not only urge them to attend, but come yourself, I am, with best wishes,
Very truly yours,

JOSEPH HYDE PRATT, *President*.

The following letters of notification and information in regard to program, arrangements for delegates, etc., were mailed to all delegates appointed, and also to the members of the North Carolina Drainage Association:

CHAPEL HILL, N. C., October 24, 1914.

MY DEAR SIR:—This is to notify you that you have been appointed a delegate to the Seventh Annual Convention of the North Carolina Drainage Association, which will be held at Wilson, N. C., November 18 and 19, 1914. I sincerely hope you will be able to attend the Convention, and assist in making it the most successful Convention that has been held in the interest of the reclamation of our swamp and overflowed lands.

The drainage of our swamp and overflowed lands has progressed very satisfactorily, as is indicated by the enclosed circular, which will give you some idea of the magnitude of this work in North Carolina. The various problems that have come up in connection with this reclamation work will be considered and discussed at the Convention, and should be of interest to all those who are engaged in drainage work.

Another phase of this work that will be given a prominent place on the program is tile drainage.

Papers will be prepared by men who are experts in the various lines of drainage work, and after the papers have been read, they will be discussed, and all attending the Convention are cordially invited to take part in the discussions.

As we desire to have as large an attendance as possible at the Convention, in order that the various drainage problems may be more thoroughly considered, I will appreciate it if you will send me the names and addresses of any persons who are interested in drainage work, and who would like to attend as delegates.

Trusting to have the pleasure of seeing you at the Convention, and with best wishes, I am,

Yours cordially,

JOSEPH HYDE PRATT, *President*.

CHAPEL HILL, N. C., November 9, 1914.

MY DEAR SIR:—I sincerely hope that nothing is going to interfere with your being with us at the Convention of the North Carolina Drainage Association at Wilson, North Carolina, next week, November the eighteenth and nineteenth. This is a most important Convention, and we hope that every county and every section interested in the drainage of swamp and overflowed lands will have a large number of delegates present.

For the information of the delegates I would say that the headquarters of the Convention will be the New Briggs Hotel, where the rates are \$2.50

without bath, and \$3.00 with bath, a day. Other hotels are the Imperial and the Seabrook, where the rates run from \$1.50 to \$2.00 per day.

The sessions of the Convention will be held in the City Building during the day and in the Courthouse at night.

We are expecting some very interesting speakers. Among them will be:

Hon. E. J. Watson, Commissioner of Agriculture, South Carolina.

Mr. H. M. Lynde, Drainage Engineer, U. S. Department of Agriculture, Washington, D. C.

Hon. John H. Small, Congressman from the First District.

Hon. B. E. Rice, Land and Industrial Agent of the Norfolk Southern Railway.

Hon. M. V. Richards, Land and Industrial Agent of the Southern Railway. Commissioner of Agriculture, Hon. William A. Graham.

Mr. C. W. Mengel, of the John L. Roper Lumber Company, and others.

One of the subjects which will be taken up in considerable detail is tile drainage. Also, the drainage law will be taken up and discussed and suggested amendments asked for.

Trusting that you will not only come, but interest others in your section, I am, with best wishes,

Yours very truly,

JOSEPH HYDE PRATT, *President.*

PROCEEDINGS
OF
SEVENTH ANNUAL DRAINAGE CONVENTION

HELD UNDER THE AUSPICES OF THE
NORTH CAROLINA DRAINAGE ASSOCIATION AND NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY

WILSON, N. C., NOVEMBER 18 AND 19, 1914

MORNING SESSION—Wednesday, November 18

The Seventh Annual Convention of the North Carolina Drainage Association was called to order at 10:30 o'clock in the opera house, Wednesday, November 18, by President Joseph Hyde Pratt.

The Convention was opened with prayer by Rev. T. W. Chambliss, pastor of the Baptist Church:

Our Heavenly Father, we thank thee for the privilege of living in this age. We thank thee for the opportunity of building greater things in thy name and for thy glory. We praise thee for the blessings which have come upon us in the passing years. We thank thee at this time that the spirit from thy throne seems to direct our nation and that we are at peace.

We come to thee this morning, as we assemble here, to discuss larger measures to benefit the people of our State, and we ask thy blessing and thy guidance, praising thee for the privilege of thy being with us in the upbuilding of the commonwealth. We ask thee, O Lord, that all we do, all that we accomplish, and all of our plans and creeds shall be to thy glory and to the upbuilding of a nation to thy name; and we ask it in the Redeemer's name. Amen.

Addresses of Welcome

Following the prayer, Mr. Lawrence Brett, in the absence of Mr. O. P. Dickinson, mayor of Wilson, made an address of welcome on behalf of the city of Wilson, as follows:

Mr. Chairman and Members of the Convention:

I have been asked by Mr. O. P. Dickinson, Mayor, to extend his hospitality, as Mayor of the town, to this Convention. Mr. Dickinson is engaged this week in court, and it is impossible for him to leave at this hour. Dr. Dickinson wishes me, on behalf of the Town of Wilson, to extend a very cordial welcome to this, the Seventh Annual Convention of the North Carolina Drainage Association.

On behalf of the Chamber of Commerce I wish also to extend a hearty welcome. If the weather had not turned quite so cold I was going to say that I would extend a very *warm* welcome, but the heating plant in this building being out of commission just at this time, we are not able to make it quite as warm this morning as we would like.

The people of Wilson are very deeply interested in the work of drainage. We have for several years had representatives attending the various drainage association meetings in the State, and in every place we have been well entertained and have had very profitable meetings. We hope to make this meeting one of the most successful of the series, and on behalf of the Chamber of Commerce of Wilson, and the Entertainment Committee, we wish to thank you for your presence, and we want to do for you all that we can to make your stay a pleasant one.

Wilson County extended a welcome to the delegates through Mr. W. F. Woodard, Chairman of the Board of County Commissioners:

Mr. President, and Members of the North Carolina Drainage Association:

It gives me peculiar pleasure to welcome you to our midst. I expected a speech of welcome to be made by our Mayor; therefore I have not prepared anything to say, but as chief executive of this county I give you a most hearty welcome to our midst.

It is peculiarly fitting that the North Carolina Drainage Association should meet with us here in Wilson County, in that we have probably the first drainage district established in North Carolina after the United States Department of Agriculture had added to its experiment station the department of drainage. About a mile from Wilson, on the Tarboro road, is located a canal that we have dug. This canal is about twelve miles long, extending from the Atlantic Coast Line Railroad to the Toisnot Creek. The plans, profile and specifications for this canal were made by the United States Department of Agriculture. Mr. H. A. Kipp was the drainage engineer in charge. Mr. Lawrence Brett, who is an officer of this Association, contracted to do this work for us, and it was done satisfactorily in every respect. I hope you gentlemen will take the opportunity to visit this canal while you are here with us. Incidentally, while going to see this canal, cast your eyes to the left and look at the fine blue grass pasture you will see there—blue grass growing from seed sown on land practically without any preparation at all.

Gentlemen, the latchstring hangs on the outside, and all you have to do is just ask for what you want, and it is yours.

The response to the addresses of welcome was made by the President of the Association.

It is my pleasant duty to make the response to the addresses of welcome. I think it is very opportune that the Convention of the North Carolina Drainage Association has been called to meet here in Wilson at this time. As Mr. Woodard stated, the first drainage district actually established was in Wilson County—the Toisnot Drainage District. Although there had been some drainage work started before the actual digging of the canal, yet the first drainage district organized was here in Wilson County. Since the law passed in 1909, five years of drainage work has been going on in North Carolina; and now, as you will see from the map on the wall, there are seventy-two drainage districts organized, or in the process of organization, in North Carolina, either in the swamp lands or the overflowed lands of the Piedmont section. Many of these districts have been completed and the land is now in cultivation.

I said it was rather opportune that we meet here, because there has come up in the last year particularly, one question or phase of the drainage work that needs to be solved and worked out, and I believe the people of North Carolina are looking to the North Carolina Drainage Association to help them solve that particular problem, and that is—making use of, or bringing into cultivation the lands after they have been reclaimed by drainage.

Now, as you compare the overflowed areas with the swamp areas and work out the percentage of land under cultivation in each section after being reclaimed, you will find that in the overflowed districts a very large percentage of the land, immediately after it has been reclaimed, is brought under cultivation; while in the swamp areas there is a very large area which remains uncultivated for some time after the district has been organized and the canals dug. Now the reason for that is that in the Piedmont district, where you have the overflowed areas, the lands are owned by small land-owners who cultivate the lands themselves; while in the swamp areas the lands are very often held by men who own large areas and the greater portion of their holdings are for sale and not for cultivation by themselves. That means that in the Piedmont district we are not looking for any one to come in and settle on these areas that are being reclaimed, while in the swamp areas we are looking for others to come in and settle, and take up the cultivation of these lands.

We are all very much interested—deeply interested—in this great European war, and it seems to me that it is going to have a direct bearing upon the development of our swamp lands here in North Carolina. That is, if we should take upon ourselves as an Association to try to work out a plan by means of which we can call the attention of the Belgians and others of the European nations who are accustomed to work land such as we have here in eastern North Carolina, to the opportunities here and try to interest them to come over and become home-seekers here in eastern North Carolina, and take up these areas of our reclaimed swamp lands. I do not believe we could find a better class of immigrants to try to bring into eastern North Carolina, for they would become good, substantial citizens of the State, especially the Belgians, and perhaps some of the families from Holland who have been accustomed to work reclaimed land and are doing intensive farming. They are also extremely expert in dairying and I believe a plan can be worked out by a committee appointed by the Association by which, in coöperation with other bodies, we can arrange to bring a considerable number of such people into eastern North Carolina. The start has already been made. I was in Georgia last week and in talking with the people of Atlanta, who have formed an organization there to take up the same question, they agreed to keep me posted as to what they accomplish, and I have agreed to keep them posted as to what we do in North Carolina, to see if we cannot send a delegation abroad and actually bring or induce those people, by telling them what we have, to come in and become a part of us in the development of the swamp lands of eastern North Carolina.

Mr. Woodard spoke of taking us out to see Toisnot Canal and the land that has been reclaimed, and what it is producing at the present time. He also stated that we had a perfect drainage law. It is perfect as far as it goes, and as perfect as the Legislative Committee that was appointed by the Association to draw it, could prepare it at that time, without ever having worked under

such a law. As you all know, that law was passed without a single amendment. Although twenty-nine amendments were introduced, they were all voted down, and the law was passed as drawn up by a committee of this Association. In 1911, after working under the old law for two years, the Legislative Committee found, after investigation, that certain amendments were necessary, and there were passed at the 1911 General Assembly those amendments to the North Carolina drainage law that were recommended by the Legislative Committee of this Association. Then they thought they had brought it up to what was as near perfect as possible. After two years' work on the law it was found that still other amendments were needed to make it more operative and to get better results. We were not quite so fortunate with the Legislature of 1913, and the amendments suggested by the committee were not passed. If the appropriation had been left out I think every amendment suggested would have passed, but it carried an appropriation, and I think the appropriation killed all the suggested amendments. However, I want to bring this point out: There was not a single drainage act passed by the General Assembly of 1913 that was not recommended by your committee; so that the influence of this Association, the North Carolina Drainage Association, is recognized by the people of North Carolina, and by the General Assembly. They realize that the men who are connected with it, and the men who are interested in the reclamation of the swamp and overflowed lands of North Carolina have given thought and study in every way as to what is the best law or legislation to pass to make the reclamation of these areas more effective.

Now, your Legislative Committee has been busy since the Legislature of 1913, and they will have certain recommendations to make to this Convention as to what they think should be passed by the General Assembly of 1915. The committee will also be in force and will meet during the sessions of the General Assembly and do whatever they possibly can to see that the recommendations of this Association are passed. I know that some of the delegates to this Convention have come up particularly to take up certain phases of legislation that they have found, in connection with the work in their districts, necessary to make the plans of carrying out the work of their section more effective.

One thing I do want to emphasize was the question of bringing under cultivation the lands after they have been reclaimed. I think you will all agree with me that there is no question now of stopping drainage work in North Carolina. I think both in the eastern North Carolina swamp areas and in Piedmont North Carolina that the work has gone to such an extent and has been so satisfactory that districts are going to be continually organized and the work carried on, but there is that question to take up now—the means by which we can bring under cultivation these lands after they have been reclaimed—and I think those who are interested in the large areas would like very much for this Association to take up more actively some plan by which such can be accomplished. I make the suggestion that during the business of this session we authorize the appointment of such a committee to take up that question.

There is one other thing that has come up during the past year in regard to our drainage work, which is similar to a problem we have in connection with roads: We have no trouble, or very little, in raising revenue for the

construction of roads. The main thing is to get the people of North Carolina to realize that after they have built the road they must have a revenue to maintain it and keep it in good condition. The same thing is true in regard to drainage districts. Do not let us make this mistake in regard to the maintenance of canals and ditches in drainage districts. Keep them clear so they will take care of the water. After building them, make provision for their maintenance.

Another thing has come up during the past year that I want to mention. As I stated before, there is no question now about the drainage work continuing in North Carolina, and there is beginning to be a tendency to try to take up the reclaimed lands that have not definitely been proved to be worth while. We have still left nearly a million acres of swamp land in North Carolina that is of sufficient agricultural value to make the drainage of them profitable, provided a plan is worked out for disposing of the land after it is drained. But there are certain areas that are not of sufficient agricultural value to make it profitable to reclaim the lands, although the engineering problems are easy. There is beginning, and I want to see it checked if possible, a tendency to take up such areas and drain them, with the idea that any land in eastern North Carolina is just as good as any other land and any swamp area can be drained and made a profitable area.

I am now going to revert to the Belgians for just a minute. I believe if we can bring over a certain number of these Belgians as families, have them settle in different parts of our swamp areas and other areas in North Carolina, that they will begin to teach us one thing that will be worth a great deal to us, and that is more intensive and diversified farming. And instead of ever again having North Carolina and other sections of the South so dependent upon one crop that if anything happens to the market of that one crop we will all say we are bankrupt, we will raise other crops as well. Now we speak of cotton as king—"King Cotton." I want to see North Carolina and the other southern states dethrone King Cotton and let diversified farming become king in its stead. If we will do that and the Belgians will help us, we will never again get in the condition that we are in today, where we have made ourselves so dependent on the one-crop system in many sections. You all know that we have raised on plantation after plantation nothing but cotton, and have bought everything else. If we had diversified farming we would not have to be dependent on selling our cotton to get money back into circulation. I want to see King Cotton dethroned and diversified farming take its place.

I wish to thank the Mayor, through Mr. Brett; the Chamber of Commerce, through its President, and the members of the Board of County Commissioners, through Mr. Woodard, Chairman, for the cordial addresses of welcome and the welcome they have extended to us. As Mr. Brett says, it is a little bit cold in here, but if you know the people of Wilson as I do you know that they extend to us a most cordial, a most hospitable and a most warm welcome. While we do not get the warm part in this building, we will get it tonight when we attend the reception and smoker at the rooms of the Commonwealth Club, and I, for one, am very glad to be able to come here to Wilson in connection with the Drainage Convention, because this Association has had strong support from Wilson and vicinity as perhaps from no other section of North Carolina, and the people of Wilson have realized the value of drainage and are ready to spread the gospel of drainage to every section

of the State and help this Association in every way possible to extend this great movement throughout North Carolina, which means so much to the welfare of eastern North Carolina.

In behalf of the Association and in behalf of the delegates attending this Convention I wish to sincerely thank the people of Wilson and all who have taken part in preparing for this Convention and for the welcome they have extended to us.

The following letter from Governor Locke Craig was read by the President of the Association.

EXECUTIVE DEPARTMENT.

RALEIGH, N. C., November 14, 1914.

President North Carolina Drainage Association, Wilson, N. C.:

DEAR SIR:—I regret very much that a previous engagement prevents my attending the Seventh Annual Convention of the North Carolina Drainage Association. I am well acquainted with the drainage work that is being done in the State, and appreciate the value of this work to the development of both the Piedmont and Eastern North Carolina. I can assure you that I am ready to assist in every way I can the work of this association, and the advancement of the drainage and reclamation work in North Carolina.

Very truly,

(Signed) LOCKE CRAIG,
Governor.

Secretary's Report

The President stated that it would be impossible for Mr. Skelding, Secretary of the Association, to attend the Convention, as he was sent by Mr. MacRae, president of the company with which he is associated in Wilmington, on business to Philadelphia. The reports of the proceedings of the last Convention had, however, been printed, and, being accepted by the Convention, were distributed to the delegates present.

Treasurer's Report

The Treasurer's report for the year beginning November, 1913, to November, 1914, was read and referred to an auditing committee, consisting of Mr. P. H. Johnson and Mr. H. M. Lynde.

The appointment of committees was postponed until the President had an opportunity to look over the registration book and make the committees representative of the different sections of the State represented at the Convention.

The first address on the program was to have been given by Hon. William A. Graham, Commissioner of Agriculture, but as he had not reached Wilson, the address was postponed until the afternoon session.

The morning session was then open for any suggestions or business which the delegates might wish to bring up regarding the operation of the North Carolina drainage law or the work in their drainage districts.

Mr. P. H. Johnson, of Beaufort County, spoke in part as follows:

MR. CHAIRMAN:—Just before I left home I was asked by a prominent gentleman in my town, a member of the Board of County Commissioners, if I could tell him who really wrote this drainage law and who had to be responsible for it. I told him that my answer depended somewhat upon what he had to say about it. * * * I told him if he wanted to praise it, why a lot of us had something to do with that law, but if he wanted to condemn it, it would be very hard to find a man who would stand behind it. I have been on both sides of the proposition. I believe I have seen about as much profit and enjoyed about as many benefits from this drainage law as any man in the house. I went further and asked this man why he asked me this question, and he asked me if I thought the people who drafted this law had any idea that any of the land would be sold within ten years after it was drained. Then I saw what he was leading to.

We have rather a peculiar condition. Under our drainage law we file ten books with the sheriff and with the clerk of the court, as you all know, in which the taxes (?) are listed for ten consecutive years, and none of that tax (?) is due within ten years, and, unlike our ordinary tax books that are made for each year, they are made up for ten years. We have no physical sign of the location of the different classes of land in this district. We have five classes. One man may own a tract of land in which some of that land may be in each of those five classes. The law specifically states that the tax shall rest against that land and not against the individual. * * * Suppose a man has a tract of land and sells one hundred acres and keeps four hundred acres. Now the question arises: What class is that hundred acres in that he has sold? The second question is: Who has the authority to change that sheriff's books? After carefully studying this law I have been unable to find out who did, and I will go further to say that I have consulted Mr. Small, who, I believe, has been associated with this Association since its beginning, and other lawyers, and nobody yet has been able to tell me who has the authority to change this tax list. I do not think there are but two, and I am sure there are not over three districts in the State that have begun to collect their taxes yet, and I have come here to have a heart to heart talk with any representatives of these three districts, and I want to know if they have devised any means to settle this difficulty. I will say that we have changed the tax ourselves without authority of law, and trusted the people who own this land to live up to it, and in most instances they have. In some cases they have given us trouble, and were it not for the fact that our money was deposited in the bank at four per cent and we had that interest to draw upon, we would have been swamped. It seems to me that this Convention should consider this point and should adopt some means whereby either the seller or the purchaser of land should immediately list this property with some officer of that particular drainage district, and at the end of each year that officer should file an amended list with the sheriff so that he can go on and collect his tax. That is one question that I think is vital for us to consider.

We have another problem, and every time I attend a drainage convention I expect to bring it up. That is, in the matter of classification. In some districts we may have enough classes, but in our flat land country we have sixteen thousand acres drained by two canals—one nine and the other eleven

miles long. * * * Near the outlet the land is already developed. Most of it is cleared, being cultivated, and up at the head of the canal it was a swamp that was absolutely worthless and only valued at \$50 on the tax books, under water all the time. When these commissioners or viewers started to assess this tax, they began at the mouth and as they went up they raised the tax, and when they got about three miles from there they got to class A and cut two canals through a swamp that would drain a man's land five miles off. * * * That is the condition we have had to face, and I believe that you gentlemen who are now organizing districts and expect to do so in the future can well profit by our experience and ask this Drainage Convention to permit the assessment to go further and extend it to ten classes. It may be that in a great many instances that five are sufficient, where all the land is in the same state of cultivation; but in this flat land country, with patches here and there developed and the rest wilderness, we certainly have not enough classes, and I believe that this Legislative Committee should recommend that change.

The third recommendation that I would make is that I find no authority of law to change our drainage commissioners. They are elected for life, it seems. There is no provision even for a man's resigning, and if he does resign there is no provision for electing another. As Dr. Pratt has well said, we began all right, but it might be time now to make some change. In the matter of payment for the commissioners, the law did not contemplate any payment. I think the last Legislature did that. I have had the displeasure, if I can express it that way, of being chairman of a drainage commission for four or five years, and in the last two years I believe I can safely say that I have done five hundred dollars' worth of work, and I have never had a meeting of the drainage commissioners, and, therefore, would not be entitled to pay. I am not asking for any continuance of this office or pay, but I am stating the facts. In states where everybody has been educated to the operation of this law, why that condition might be logical, but we have to conduct an educational campaign wherever we have a drainage district and that man who has land in that district must be informed in regard to the drainage law and he must be told why his neighbor is in one class and he in another. * * * Aside from that, when you begin to collect your tax, you will find a great many people who are disposed to take advantage of a certain number of technicalities that have outcropped in a district. * * * We may have an exceptional case, but I believe the chairman should be paid a reasonable sum—say fifty dollars a year, and the other commissioners should be paid for their time when they are called to do anything, and let all be paid for their expenses. I have had to go to Norfolk in connection with this, and had to spend some time and money. I am just mentioning my own experience in order that you may understand in case it happens to you.

* * *

I do not think I have anything else to propose.

DR. PRATT: I might say in regard to the first suggestion that Mr. Johnson brought up about keeping track of the land as it is sold and the land in different classes: That was taken up very thoroughly at the Raleigh meeting and the Legislative Committee worked on it and it was drafted into a bill. Mr. Johnson brought the same thing up at that meeting, which was

thoroughly discussed, and an amendment was worked out which Mr. Small and a couple of others who were with us considered satisfactory. That was one of the sections of the bill introduced in 1913 that was not passed. * * * Take the case mentioned of the man who had five hundred acres of land. He sold one hundred and kept four hundred. It was a question about the one hundred acres. If that law had been passed in 1913 * * *

The other question in regard to classification: That has been more or less a bone of contention ever since we organized, but how many classes would be necessary in order to equitably divide into districts classes for assessment? That will come up later in connection with the discussion of that proposition. But it is one of those things that needs discussion and needs to be worked out.

In regard to the pay of commissioners: That has not been worked out as satisfactorily as we want it. But you know the General Assembly, when it comes to the question of paying out money or authorizing the paying out of money or making of appropriations, is a hard proposition to run against.

Mr. D. B. McNeill, of Robeson County, had the following suggestions to make:

This is our difficulty: About March, 1912, we organized or finished our drainage district. I think the law says after three years you commence collecting taxes. August the first we sold our bonds and our first installment is due the first of next August, 1915, and we could not think about collecting any tax on it before the following October or November after that. Then if that was only one year we could borrow the money for that length of time, but we would have that to contend with each year after that for the ten years, and then this year the cotton situation has gotten us all down there and we want to know if there can't be recommended by this Association a law enabling drainage districts to sell additional bonds for two years, making it a fifteen-year bond, and the first two bonds we sell to tie down to the last of the list to take care of the first two issued, and that will enable us to collect taxes in the fall of 1916 to be paid in 1917. Two additional years of bonds to refund the first two years are the ones which are due under the thirteen-year plan.

The President of the Association called the attention of the delegates to the exhibits of tile drainage, prepared by Mr. F. R. Baker, Drainage Engineer of the Department of Agriculture of North Carolina. This exhibit was a splendid representation of a farm on which had been installed a system of tile drainage. Attention was also called to the maps and charts of drainage districts completed displayed on the walls; also maps and pictures prepared showing the location of seventy-two districts in North Carolina.

Mr. Brett announced that following the afternoon session an automobile ride and a practical demonstration of laying drain tile by Mr. J. C. Cowley had been arranged for. He also extended on behalf of the citizens of Wilson the privileges of the Commonwealth Club to the delegates in attendance at the Convention.

Upon motion the Convention adjourned to meet at 2:30 o'clock in the City Hall.

AFTERNOON SESSION—Wednesday, November 18

Appointment of Committees

The Convention was called to order by the President, and the following committees appointed:

COMMITTEE ON RESOLUTIONS.

Mr. W. K. Allen, <i>Chairman</i>	New Hanover County.
Hon. John H. Small.....	Beaufort County.
Mr. H. M. Lynde.....	Wake County.
Mr. J. G. Mills.....	Wake County.
Mr. P. H. Johnson.....	Beaufort County.
Mr. S. E. Poe.....	Gaston County.
Mr. J. C. Stanton.....	Wilson County.
Mr. M. E. Sherwin.....	Wake County.
Mr. Charles A. Land.....	Wayne County.
Mr. Zeno Moore.....	Edgecombe County.

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

Mr. John A. Wilkinson, <i>Chairman</i>	Beaufort County.
Mr. D. B. McNeill.....	Robeson County.
Mr. R. M. Squires.....	Wake County.
Mr. C. W. Mengel.....	Washington County.
Mr. F. R. Baker.....	Wake County.
Mr. T. W. Chambliss.....	Wilson County.
Major W. W. Peirce.....	Wayne County.
Mr. N. B. Boddie.....	Nash County.

MEMBERSHIP COMMITTEE.

Mr. M. E. Chappel, <i>Chairman</i>	Hyde County.
Mr. E. E. Schooley.....	Beaufort County.
Mr. K. W. Barnes.....	Wilson County.
Miss H. M. Berry.....	Orange County.
Mr. H. D. Brown.....	Wilson County.

LEGISLATIVE COMMITTEE.

Mr. Lawrence Brett, <i>Chairman</i>	Wilson County.
Mr. M. F. H. Gouveneur.....	New Hanover County.
Hon. John H. Small.....	Beaufort County.
Mr. E. B. Crowell.....	
Mr. John P. Kerr.....	Wake County.
Mr. M. W. Thompson.....	Guilford County.
Mr. J. L. Becton.....	New Hanover County.
Mr. J. B. Sellers.....	Robeson County.

The Upbuilding of Eastern Carolina Through Drainage and the Resulting Benefits to the Railroads

MR. B. E. RICE, LAND AND INDUSTRIAL AGENT OF THE NORFOLK SOUTHERN RAILROAD.

Mr. President and Members of the Association:

The public is beginning to realize more each day that a railroad in its operation is similar to a merchandising corporation—they have something to sell and that something is transportation. The railroad is seeking for buyers of transportation the same as the merchant is seeking for buyers of his goods.

The resources of a railroad, its entire income, is based upon the sale of transportation, either passenger or freight.

As the merchant in the city strives to broaden his trade, to increase the number of his customers, to induce people to patronize his store instead of some other, so it is with the railroad. The sale of transportation is limited to the number of customers, and as their buying power is increased or decreased, so is the revenue of the railroad increased or decreased.

The sale of transportation can be decreased through poor service by the railroad or by bad business conditions of the country. If the crops are short there is consequently less tonnage to move, due to no fault on the part of the railroad operation. If the money-worth of the traveling public is reduced, either through poor crops or other causes, the passenger travel of the railroad must be decreased and no inducement on the part of the railroad can improve the percentage of travel to any extent.

The depreciated purchasing power of the public is beyond the control of a railroad and naught that a road can do will add to the sale of transportation, where the decrease is due to lessened crop production.

Any increase in the producing capacity or any improvement in the business conditions of a country traversed by a railroad increases the sale of transportation by that road. Any increase in tonnage increases the earning power of a railroad in still greater proportion, owing to there being more profit in a maximum local haul than in a minimum. The upbuilding of a district by an increased production acreage means enlarged business for the community, and a consequent enlarged business for the railroads serving that community. It not only means more tonnage to be handled outbound in the way of crop movement, but it means an increased exchange cash revenue for the community and a consequent increased earning power for the railroads.

Every additional acre secured to a community and operated at full-crop capacity means that the owner of that acre has additional dollars to spend, and he cannot spend this money without helping the railroad, either directly or indirectly. No matter whether he spends it for passenger travel or in the purchase of food and clothing, it means an increased railroad haul.

If we could only realize the worth of the dollar in its business changes; if we were able to trace that dollar from the time it comes from the soil, from that additional acre of new land; if we could follow that dollar in its wanderings, we would discover that in a comparatively short time it had benefited many people in the community, and had probably traveled on the railroad several times, either as passenger or freight.

We cannot too greatly estimate the value of the new acre that might be

added to a community. It is for this reason that practical drainage is of such vital importance to the railroad and to the state. The welfare of a railroad, its prosperity or its depreciation, is of as much importance to the people as it is to the stockholders of the railroad.

During the last ten years the farmers of North Carolina have been blind to the ways of the politicians. Vicious legislation has been brought about, through the support of the farmer. The misleading politicians have been placing upon the railroads the blame for all the ills of the country. This same vicious legislation, in its effect on the railroads, has reacted in harm to every citizen of the state; every man, woman and child is effected equally with the stockholders of the railroad.

With decreased earning power there must be a forced decrease in railroad operating expenses; a compulsory reduction, regardless of what might be the desire of the railroad management. This reduction in operating costs of a road must result either in the operating of less trains or slower schedules, a reduction in equipment or in the number of employees, or in various other ways, every one of which is to the inconvenience or some form of loss to the traveling and shipping public.

All this has been brought on by the politicians, who in their anxiety for office have used the farmers, the producing people of the state, as stepping stones to political positions. The traveling and shipping public who complain as to decreased railroad accommodations should stop and consider that it is the politician alone who has brought about this change, and they should further realize the fact that no politician ever gets into power except by the votes of the people.

As land is the only possible means for the direct creation of money value, a railroad is directly benefited by every additional productive acre that can be placed in its territory. Each additional acre increases the earning and purchasing power of the township, the county, and the state. It is of still greater worth to the city, to the town, or business center where the dollar from the farm is exchanged for the products of business. This additional created dollar is also of the greatest importance to the railroad, as it not only represents a new outbound crop haul by the railroad, but an inbound haul of a dollar's worth of manufactured products that the farmer must have in exchange for his crop. All this adds to the prosperity of a railroad, and wherever you find a railroad prosperous you will find a smile on the face of the people of the community. The reason is manifest in the fact that the people must likewise be prosperous. They are also in position to enjoy the favor of better railroad accommodations, due to that same prosperity, the additional dollar produced by the added acre of land.

Elbert Hubbard says: "Farming is the primal need, because we get our food out of the soil; next to food is love, and no man is loving, lovely or loveable, who is on half rations." Perhaps Richard Cobden put this more concisely when he said, "The ratio of marriages keeps pace with the price of corn." Only well-fed people are capable of love, and a corn-fed product is always prosperous.

With reference to the value of railroad service, Elbert Hubbard further says, "Next to farming in importance comes transportation, because a thing has to be at a certain place at a certain time in order to possess value. The railroads bridge time and annihilate space." The railroad is therefore the

connecting link, from this new acre, to take the product to where it will be of value. The crop is of no value where it is grown; the bale of cotton, the bushel of corn or the meat-producing animal is of no cash value while it remains on the acre which created it. It must be transported to where it becomes of market value, and the railroad is the essential factor for its moving.

Thus the railroad becomes a partner in the creation of business for a country, but too oft do people fail to give to the road the small meed of praise that is due. Too often does the railroad get censure instead of credit. The public fails to realize that the service possibilities of the railroad must inexorably depend upon the earnings from public patronage. The farmer should also remember that the possibilities of the railroad depend primarily upon the producing power of his farm, the prosperity keeping pace with the increase or decrease of farm acreage.

If the farmer could but realize that his business partner, the railroad, is so seriously affected by vicious legislation then perhaps he would be more consistent in his voting of dangerous politicians into power. If legislators could be made to realize the value and possibilities of good, effective drainage legislation, and could be made to appreciate the dangers and loss from vicious and ignorant railroad legislation, then perhaps they would devote less time to showing railroad officials how to manage a railroad, and with the result that the country and the railroads would be far more prosperous.

With over three million acres of undeveloped farming lands in North Carolina today, awaiting discovery and drainage, there surely is a prime and important need to bring these acres under cultivation. The railroad is vitally interested in the additional acre, but not more so than should be the people of the community, and the state.

The additional acre secured by drainage is an acre worth more than double the acre under long cultivation. This is because the land that needs the drainage has for centuries been accumulating valuable plant deposits and soil worth. Not until proper drainage is effected will this acre ever become available and be converted into a producing factor. Not until it engages in food-making can it aid in love-making and marriages.

The uplands of the state do not show the natural fertility that you find in the bottom lands. As a state North Carolina represents a condition from mountain-top to sea-level. In my talks with people from the western states they often refer to the "poor worn-out lands of North Carolina." My explanation is that they must have visited the higher parts of the state, where ages ago the fertile surface soil was washed into the more low-lying districts. For centuries these lower lands have been undrained and unfit for cultivation. Recent drainage laws of North Carolina are now making these thousands of acres available. The many and rapidly increasing drainage districts of the state are working wonders, and every new acre that is obtained by drainage has a fourfold value, due to its rich producing possibilities.

Thousands of people from the northern and western states are actively and anxiously looking about the South to find certain conditions that will conform to their desires. Seeking a mild climate and low-priced lands they will not be content with the lands that are low in price because of a low producing power. For this low price they must have a rich soil acre. In North Carolina, through drainage, we can create an almost unlimited acreage that while being low in price is capable of the greatest possible production.

As an instance of value of drainage I cite a case from the central part of the state, where a tract of about 50 acres of land, subject to overflow, was reclaimed by canal system. It had never been possible to grow a crop on this land on account of frequent overflow, but as canal construction afforded perfect protection the entire tract was brought into crop production. The owner of this land is authority for the statement that the first year's crop paid the entire cost of canal construction. The real fact was that upon this 50 acres was deposited fertility from more than a hundred acres, all a waste until redeemed and made productive through drainage.

The wonder of today is why drainage was not started in North Carolina a century ago. Had such been the case, instead of there being millions of idle acres in eastern North Carolina today we would have a dense and wealthy population, an area of wonderful producing worth and earning power, a soil value per acre greater than elsewhere in America. The northern and western states are densely populated, and represent an area of high-priced acres. The overflow from the states is seeking a new lodging place and the beckoning hand should point to the wonderful advantages of eastern North Carolina; its rich, wonderful lands, its markets and its mild climate. We have here what the west and the north are seeking, but only through drainage can our lands become available.

A change must be brought about. We must change the condition of the lands; we must change the location of the people. In this change the Norfolk Southern Railroad is greatly interested and stands ready at all times to actively coöperate with organizations and interests that are or may be induced to work along these lines.

Tile Drainage

MR. M. E. SHERWIN, PROFESSOR OF SOILS IN THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

It is a pleasure to me as well as an honor to address this Convention on the subject of "Tile Drainage." Especially is this true in view of the fact, as I understand it, that the North Carolina Drainage Association is now for the first time giving attention in its convention to this subject—a subject which I predict will in the near future claim a major portion of its time.

Tile drainage is a logical conclusion of a drainage district project. It follows the drainage district project just as naturally as harvest follows seed time, and in a certain way it bears the same relation to it; that is, it is the final reward of all the labor and effort that has been previously expended. In addition to paying its own cost, the greatly increased yields obtained justify the enormous expenditures of the laying out and completion of the drainage districts, the chief function of which is the lowering of the water table to allow sufficiently low outlets for the tile drains.

This lowering of the water table, I might say, has in many cases been a real necessity and prerequisite to satisfactory tile drainage. In many cases it has been impossible to get a flow of water from the land till a lower outlet than previously existed was made possible. So that we may say that if tile drainage naturally follows district drainage, then district drainage naturally precedes tile drainage, showing that this Convention in giving its attention first in point of time to that larger, broader and less detailed work and now

coming to tile drainage or drainage of the individual farm and field has not been illogical.

Let us not at this time stop the drainage district work but let us increase the attention given to tile drainage, for in the not very distant future this will be looked upon as the great work of the Drainage Association and of practically all persons interested in drainage. This may not come till near the completion of the larger projects in this State, but it is bound to come.

That underdrainage is more satisfactory than open drainage will be conceded by all because of (1) the cutting of what should be large and easily worked fields into small bodies of land by open drains; (2) the loss of tillable land along the open ditches; and (3) the relative slowness with which water percolates into open drains. These three points have been so generally conceded that I shall not discuss them.

That tile is the most satisfactory of all materials for underdrainage must be conceded when we consider cost, efficiency, and duration of all materials. The cost of any underdrainage may be reduced to two items; first, the cost of labor; and second, the cost of the material that is used. The cost of labor is half the total cost of tile drainage in North Carolina, and is equally great regardless of the material other than tile that may be used. So there can be no saving on labor, no saving on that half of the cost of drainage by the use of other material than tile. In some cases the labor of ditching is greater for the other materials than tile because these materials require larger, wider ditches, making the handling of more dirt necessary. Certainly no saving can be made in the item of labor; let us consider whether any saving can be made in the other item of cost by the selection of materials other than tile.

Among materials to be considered are plank, poles, rock, and brush. At market prices the lumber for small plank drains will run a little lower than the cost of tile, but for the larger drains a little higher than for the cost of tile. As an average, we will find no saving in first cost. And when we consider the life of the two materials we have to throw the plank out of consideration at once as plank put in a soil which is subject to considerable variation in moisture content has a very short life. In a soil which remains waterlogged, plank drains will last a long time, but we must consider that a field which remains waterlogged is improperly drained and hence that plank is not the material to use in economical and efficient drainage.

Poles have been used and are sometimes cheaper than plank, but their low efficiency in the carrying of water and their short length of life make them very expensive drains in the end.

Rock is another material sometimes used. The cost of installing this is certainly greater than the cost of installing tile. Where it is used the rock is abundant and costs nothing but the hauling, but this cost is tremendous, as any of you that have ever tried rock hauling know. The only conditions under which rock can be used profitably are that the rock must be gotten rid of for other reasons and that there is no waste land on which to pile them. Under these conditions they can sometimes be profitably buried under-ground, but they serve generally as poor water channels in comparison with tile.

Brush has sometimes been used as a material for underdrainage. It is very inefficient as a carrier of water and its life being so very short it cannot be considered as a material for permanent drainage.

So, after considering the cost, the efficiency and the length of life of all these materials that may be used for underdrainage, tile must be recognized as supreme; and if we look at the experience of other states we would decide that our conclusion is correct, for all the states that have done any great amount of underdrainage have used for years past practically nothing but tile. They have abandoned the plank, the pole, the rock, and the brush, and are using very large amounts of tile. I wish we could say that North Carolina has put in a large amount. The time will come when we can say that.

At this time I want to consider briefly the benefits of thorough drainage. I shall not go into this subject very extensively. I have a few diagrams here that I want to show and the following list of the major benefits of drainage.

1. Improves the granulation of clay soils.
2. Increases the water-holding capacity.
3. Improves the aeration of the soil.
4. Deepens the rooting of crops.
5. Promotes the growth of desirable bacteria.
6. Reduces the erosion of sloping lands.

Let us consider these benefits one at a time.

It improves the granulation of clay. If we examine a clay soil and rub between the fingers what we might assume to be one particle of clay, it will spread out to ten thousand tiny particles or single clay grains, any one of which is too small to be seen with the naked eye. A soil in good tilth has these clay grains arranged in groups which we term granules or crumbs. You can see by the accompanying diagrams, page 27, that if we have the single grains massed together as in Fig. 2 the spaces intervening between the grains must be very small. If we get those grains grouped as in Fig. 1 we will have the same sized spaces within the granules (compare Fig. 1 and Fig. 2) and will have additional larger spaces between the groups of grains (Fig. 1). These spaces between the groups of grains compare in size very favorably with the spaces between sand grains in a sandy soil, so that such a granulated clay in its moisture and air relations has the desirable qualities of a sandy soil but without the undesirable qualities that some sands possess.

It increases the waterholding capacity. The water in any soil is held on the surface of the soil grains and in the open spaces between grains and between granules. It is not absorbed into the mineral substances of the soil. In an ungranulated clay soil, as can be seen from the diagram, Fig. 2, page 27, the grains are so massed together that there is not much space for water without almost total exclusion of the air. That tile drainage increases the amount of available or capillary moisture is shown by the following table, the result of an experiment by the late F. H. King, of Wisconsin, formerly chief of the Division of Soil Management, U. S. Department of Agriculture.

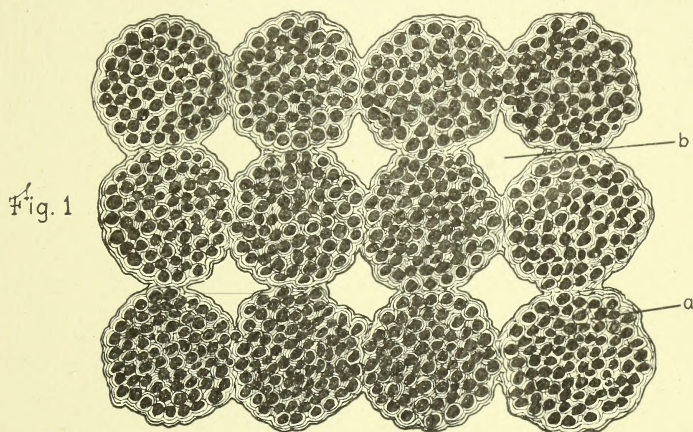
	<i>Capillary water absorbed by 36 inches of soil.</i>
Drained	7.50 inches
Not drained	6.66 inches
Difference	.84 inches

In this experiment in which both soils were dried before testing them in respect to absorption of water the previously drained soil was shown to

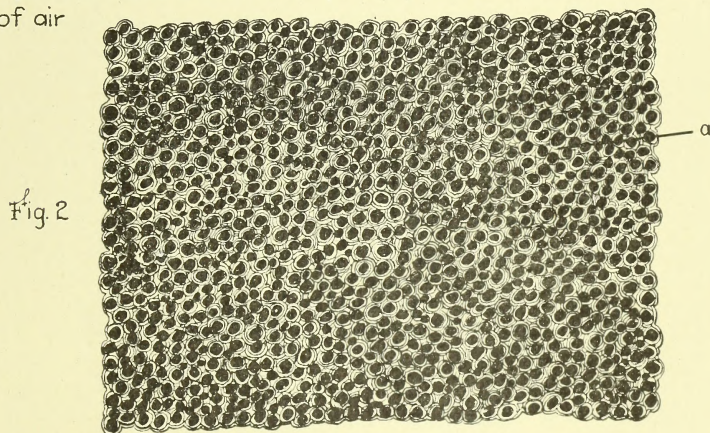
absorb more than four-fifths of an inch of rain in excess of that absorbed by the previously undrained soil. This is equal to nearly two hundred thousand pounds of water per acre.

It improves the aeration of the soil. The drained soil which has become

Ideal grouping of soil grains induced by proper drainage.
Note the abundance of pore space for both water and air.

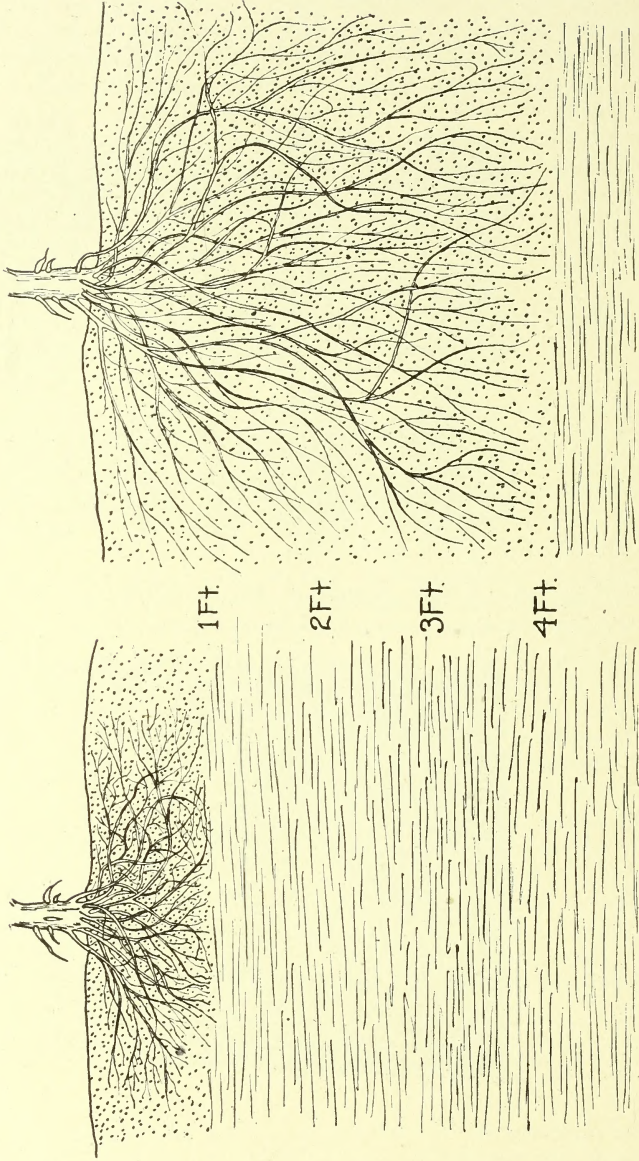


Massing of soil grains in soil puddled by lack of drainage.
Note the small amount of pore space for water and the absence of air



well granulated, in addition to having an increased storage capacity for water, has considerable space left for the movement of air (see b, Fig. 1). This air space does not appear in wet, undrained soils though air is just as necessary to the growth of ordinary farm crops as water or plant food, or any other natural substance. The roots of plants can not live without air. The killing of plants by drowning, as we say, is not due to the ill effects of

Fig. 3.
Shallow rooting with poor drainage. Deep rooting with water table lowered.



water, but to the lack of air. A man under water does not drown because the water gets into his lungs, but because the air is excluded.

We must have not only air, but fairly free movement of air, in the soil. An underdrain when not full of water furnishes an inlet and outlet for air deep in the soil, thus helping to establish free movement of air through the soil. This effect, that of supplying air through the drain and in aiding of the circulation of air in the soil has been recognized by truckers and others who have drained their soils as one of the real benefits.

It deepens the rooting of crops. If the water table is lowered by drainage from one foot to four feet, as shown in Fig. 3, page 28, the feeding area of the crop is quadrupled. On undrained land crops which are forced to root close to the surface early in the season and early in their growing period are not able to follow the moisture line downward when dry weather comes later in the season. Hence they may suffer for water though water is only a few feet below the surface. But in land thoroughly drained the crop roots go deeply while the crop is still young and able to extend its roots, and so the crop is not seriously affected by dry weather. Many soils which to the casual observer and even to the farmer do not seem in great need of drainage may nevertheless be greatly helped by it.

It promotes the growth of desirable bacteria. The "life of the soil" is made up largely of real living organisms, the bacteria and fungi. Give us a soil without bacterial action in it and we have a soil which is usually far from fertile. In a soil which is waterlogged the beneficial bacteria are unable to thrive; the bacteria which are present being usually injurious rather than beneficial. It seems that most of the helpful bacteria must have air; and to get air so that these bacteria can work is important.

It reduces the erosion of sloping land. There is vastly more loss of plant food by erosion than in all the crops that are taken from the land. Drainage prevents erosion by allowing the water to enter the soil. In a field where the soil is comparatively dry, there is considerable air present in the soil. When rain falls it wets the whole surface of the soil at once, blocking the way for the escape of the air. But the air must pass out before the water can get in, so the air is forced to bubble out through the water surface or be forced out below. In any land which has no under-drain the nearest exit below is the other side of the world, so that naturally it bubbles up through the surface water and by so doing impedes the passage of water into the soil. Our experiments at the College indicate that in our clay soils water will soak into under-drained soil 40 per cent faster than into the same soil not under-drained. This increase is due to the fact that the under-drain furnishes an opening connected with an outlet through which the air can escape; so that when rain water enters the soil it presses the air out through the drain ahead of the water. This allows, as I said, about 40 per cent more water to enter the soil and that much less to flow off over the surface. This means much in the saving of our fields from erosion.

There is just one more point I wish to make, and that is in regard to the cost of tile drainage. This will vary, of course, with the spacing of the drains. On the heavy clay soils we have to space the drains rather closely while the sandy soils will be thoroughly drained with a wider spacing. Also certain crops need a closer spacing of drains than others, because they require a quicker withdrawal of water from the land. In general it is the crops with

a high value per acre, like truck crops, that require and pay for a closer spacing of drains. So we find truckers spacing drains from 15 to 60 feet apart, while the general farmer spaces his drains from 40 to 50 to 100 or 150 feet apart.

The cost will, of course, vary with the spacing, but we may consider the average cost in North Carolina at twenty-five dollars an acre. And we should always consider this as an investment; never as an expense. It is an investment because it pays interest on the money expended. A net income of ten per cent a year would be considered a very good interest rate, and to net this at the above cost of draining the increased value of the crop would have to be only \$2.50 per acre a year. It takes no more work to plant, cultivate and harvest a crop on tile drained land than on land not drained, so that whatever the increase is, it can be considered interest on the investment. To net ten per cent, then, would require an increase of only about two and a half bushels of corn at North Carolina prices. On this basis most of our land would pay twenty-five, fifty or one hundred per cent a year for drainage. There are thousands, probably millions, of acres in the State that would pay these rates of interest for money invested in tile drainage.

The afternoon session was closed with address of Mr. H. M. Lynde, Drainage Engineer of the United States office of Drainage Investigations, who spoke on "Importance and Principles of Farm Drainage."

The Importance and Principles of Farm Drainage

BY H. M. LYNDE, DRAINAGE ENGINEER, UNITED STATES DEPARTMENT OF AGRICULTURE.

Mr. President and Gentlemen of the North Carolina Drainage Association:

I thank you for the opportunity of speaking on the "Importance and Principles of Farm Drainage." Not enough has been said on this important subject—important because it strikes home to each individual farmer who has to ditch his land to get rid of the excess water. It is admitted that drainage lies at the basis of successful agriculture in the Coastal Plain Region, which comprises an area of over 14,000,000 acres, nearly one-half the total area of the State. Everywhere one goes in this section the needs of drainage are evidenced by the large number of open ditches on nearly every farm. Most of the land is gently rolling or flat, with a clay subsoil and the underdrainage is usually poor. The average annual rainfall varies from 45 to 60 inches and many of the storms occurring are intense at the time. In the Piedmont and Mountain regions of the state, every farm has its shallow ditch through hollows or depressions to drain these places, so that the subject of farm drainage is statewide in its importance. It has been estimated that from five to six million acres of land now under cultivation is in need of better drainage in one way or another. The most important type of drainage in North Carolina today is the drainage of the large area of poorly drained farms, for is it not true that the ultimate end of all drainage improvements is the improvement of the individual farm?

True, the speaker admits that all efforts to drain individual farms without first having an adequate outlet, either one provided by nature or one constructed by man, will be useless, but thanks to the working of a good state

drainage law and the progressiveness and enthusiasm of the residents of the state, these larger drainage problems are being solved at a rapid rate and it is only a matter of time before the entire state will be provided with outlet drainage. It may be said that it has become a popular movement and probably no other state in the South is as far ahead in the development of its swamps and overflowed lands as North Carolina. But the drainage of these large areas is already keeping pace with the demand for land and so why not pay more attention to some of the lands now under cultivation and make Farm Drainage as popular as it is in the Middle West, where the soil is no better and the climate not as good as in North Carolina? Why should the farmers in the eastern part of the state take it as a matter of course to be "drowned out" about once in every four years? Already in that territory organized drainage districts have begun the preliminary work of drainage and the large open canal is frequent. But more complete drainage than this is necessary to drain the individual farm. The object of this paper is to present in as clear and concise a manner as possible the general need, together with the underlying principles of, and the many benefits to be derived from, better, shall we call it, soil drainage, which is a matter not confined to swamps or the mere removal of surface water. "The basis of good soil management is a correct water supply, not too much nor too little, but the right amount at the right time."

RECOGNIZING THE NEED OF DRAINAGE.

What lands need drainage and what are the evidences of lack of drainage or of poor drainage? As a general rule, the presence of standing water in natural depressions, in furrows, and along roadsides or for longer than a day or so at a time anywhere on farm lands is an indication of imperfect drainage. The appearance of water on the surface during the rainy season means that the water has risen from below to that position. In other words, the ground is completely saturated with water. The dwarfed appearance of crops on cultivated fields after the winter rains are over also is an evidence of lack of drainage. When it is impossible to tell by surface indications the character of drainage, the depth of the water table may be ascertained by using a hand auger. If the ground water level is found to stand too close to the surface, say one, two, or even three feet for weeks at a time, or in other words, at a point higher than that which crops would eventually extend their root system in search of food, the water will as a general thing, interfere with crop production. The nearer the surface, the poorer the drainage, under ordinary circumstances.

In providing artificial drainage for land, the problem is one largely of removing a sufficiently large proportion of the excess water that accumulates during the most rainy periods, so that the soils or crops may not suffer injury. A properly designed drainage system should provide for so rapid a removal of the water that at no point will it stand upon growing crops for much over a day. It is safe to say that all land wherein the water table is within three feet of the surface of the soil for any great length of time during the growing season, can be materially benefited. Here in the Coastal Plain Region, the annual rainfall is heavy and the storms are often intense at the time and the capacity of the soil is overtaxed, and as a consequence water fills the ground for long periods of time or stands upon the surface.

The slopes of the land, the quickness of the rainfall and its intensity are the factors that determine the ability of a region to drain itself of surface water.

WATER IN SOILS.

There are two essential kinds of water in soils, namely: 1. Hydrostatic or gravitational water; 2. Capillary water.

Gravitational Water is the water in soils that obeys the laws of gravity by moving downward through the soil. It usually comes from an external source, like surface water, springs, etc. For the proper growth of plant life the presence of air in the soil is as essential as the presence of water. There should be a proper balance of air and water in the soil spaces. Hence, it is apparent that too long occupation of the air cells by water will do harm. This occurs when there is no ready way for the escape of the water.

The water that is used and all that is needed for plant growth is known as *Capillary Water*. In well drained soils this is the water which is retained in thin films on the soil particles after the hydrostatic water has disappeared from near the surface of the ground. It is moved only by capillary attraction and is not under the laws of gravity. Its supply is replenished from the hydrostatic water. Drainage does not remove any water which would be beneficial if it remained. It simply removes the static water. It has been stated by an authority that "of the from 30 to 60 per cent of moisture which soils can hold, it is possible to remove only one-half by drainage. The loss of this quantity leaves open air spaces in the soil, although it still contains 15 to 30 per cent of its own volume of water. Plant growth requires as much moisture as this in the soil; more than this is too much, less is too little."

Some soils with a sandy or sandy-loam subsoil possess natural drainage properties so that the hydrostatic water level, or water table, is lowered a sufficient depth below the surface in a short time, so that no harm is done to the plant. Other soils, especially on land of a flat nature, with a clay subsoil, retain the water at or close to the surface for days or weeks at a time, and some means of artificial drainage must be employed. This is practically the condition prevailing over much of the Coastal Plain Region, and, also, on some rolling land near the "fall line."

Any sort of channel that rids the soil of surplus water by carrying it down through the soil first is effective. The two methods which may be employed are the open ditch and the under drain.

THE OPEN DITCH.

The open ditch has its place in all drainage work, and one of its main values is to furnish outlets for tile drains. As a means of lateral drainage, they are not the most efficient, however. In sandy ground they are probably as efficient as tile drains, but in heavy clay, or loam soils they afford only imperfect drainage, due to the slow percolation of the water through the soil and to the fact that the sides of a clay ditch become more or less puddled, which tends to seal the exposed soil spaces and impede the passage of water into the ditch. When this happens a large portion of the water flows over the surface into the ditch, rather than down through the soil, and then off. This is not a desirable condition, because the water is given no opportunity to replenish the supply of moisture. It also tends to produce surface wash and consequent loss of fertility.

For agricultural purposes the common surface ditches are of low efficiency, and expensive. They are often not deep enough and so do not remove the water from a sufficient depth of soil nor for a very great distance on either side, especially in clay soils; their grade is usually poor and the water flows slowly or not at all. The ditch obstructs the surface, cutting the farm up into irregular-shaped fields, interferes with tillage and harbors weeds. The space they occupy amounts to about 4 per cent of the area on many farms, which on valuable land is too much space to be lying idle. They interfere with the use of modern machinery and the time lost in turning the teams is a great factor to be considered. Such ditches must be renewed from year to year, all of which makes them more expensive over a long period of years than underdrains. Another objection to open ditches is the fact that they are usually not spaced close enough together to give thorough drainage, for if they were, they would be more of a nuisance than they now are.

UNDERDRAINS.

Poles, plank, brush, and stone have been used for underdrains and have given good service while they lasted. But usually the length of time that they will give good service is short, caused either by the decaying of the wood or the accumulation of silt. The best material for underdrains and the one being used more and more as people recognize its value, is tile.

In an underdrained field there is a more continuous and free flow of water than in an open ditch. All the water passes down through the soil, thus replenishing the moisture in the soil, instead of passing off over the surface, as oftentimes happens in fields drained by open ditches.

There is always to be found in the lower portions of the soil or subsoil, water filling all the spaces commonly called ground water, held there by some impervious strata. The top line of this water is spoken of as the water table. Its distance below the surface depends mainly upon the efficiency of the underdrainage, either natural or artificial. During a heavy rainfall the water table is high, often at the surface of the ground. Gravity, drawing the water down as rapidly as it can find an outlet, gradually lowers the water table. A line of tile laid in the ground provides an open channel. The particles of water nearest the drain having a shorter distance to go, find their way first into the tile, followed by others next to them. The water table between the lines of tile is gradually lowered by the water seeking an outlet into the tile lines, by passing downward and laterally to the open channel, the water table forming a convex curve. During a long dry spell this curve becomes flatter and flatter.

EFFECTS OF DRAINAGE UPON THE SOIL.*

"The first effect of the removal of surplus water from the soil is *aeration*, or the admission of air into the spaces previously filled with water.

"As a result of the aeration of the entire body of the soil, a *greater depth of soil* is the first result seen. While the soil, technically speaking, extends to the subsoil, yet only that in which air circulates can be used by plants.

"Next, by this increase in the depth of soil an *extended range of roots* is at once made possible. Experiments have shown that the roots of grains and

*From Elliott's "Practical Farm Drainage."

grasses, and often vegetables, will in favorable soils extend their roots to a depth of three or four feet, or even deeper. The roots also push themselves laterally to a greater extent in an aerated soil, all of which contribute to a vigorous growth of the plant.

"The drainage of the soil *improves the granulation and texture* of the soil. The structure is changed so that it becomes more pliable and easy of culture. Owing to the breaking up and enlarging of the capillary tubes, it retains its moisture better.

"Another beneficial effect of drainage upon the soil is an *increase in temperature*. Water is very much more difficult to heat than the solid matter of the soil. Authorities state that it requires about ten times the amount of heat to raise a given volume of water to a desired temperature as is necessary to raise an equal volume of soil particles to the same temperature. Hence the less water in the soil the more quickly it is warmed. A difference in temperature of from 6 to 10 degrees in undrained and drained soil is often noted.

"Drainage promotes the *growth of desirable organisms*. Soil investigators have demonstrated that an abundance of air, a proper amount of moisture, and a temperature between 70 degrees F. and 105 degrees F. are the environment most congenial to the growth of the desirable organisms. As we have just seen, these are the conditions of soil brought about by drainage."

PRACTICAL BENEFITS OF DRAINAGE.

The practical benefits resulting from the improved condition of the soil just stated may be enumerated as follows, as stated by Elliott in his "Practical Farm Drainage":

1. *Land is ready for seeding earlier.* As the ground thaws, the water is at once carried down to the drains. The result is that the soil is dried out more quickly, with a corresponding increase in temperature and the land is found to be ready for cultivation from one to three weeks earlier than undrained land.

2. *Crops begin a healthy growth at once* and maintain a much more vigorous growth throughout in a drained than in an undrained soil. This is due to the fact that all the conditions for plant growth are most favorable; the right amount of air, moisture, and heat, extended root range, availability of fertile elements, increased activity of beneficial bacteria.

3. *Fertilizers are not wasted by surface washing.* The fertilizers are carried directly into the soil instead of passing off over the surface.

4. *Crops are better able to withstand drought.* The greater depth of soil and the extended range of roots, together with the change in the texture of the soil rendering it capable of retaining more moisture, are among the causes which enable a crop to pass through a period of drought safely.

5. *There is no loss of crops from heavy rains.* A sufficient number of drains of proper size, accurately laid, will carry off the heaviest rainfall so rapidly as to prevent any serious injury to the crop.

6. *Frost does less injury to crops.* This applies both to late spring or early fall frosts.

7. *The profits from the land are greatly increased.* It makes hitherto waste lands highly productive. It doubles and sometimes triples the yield per acre. It lessens the expense of cultivation because young crops are no longer

drowned out, necessitating replanting and there is no waste of time and labor in cultivating irregular fields.

8. *Sanitary conditions of the farm are improved* because the removal of water by drainage lessens the danger of malaria.

9. *The attractiveness of farm premises is increased.*

10. *Disease among farm animals is decreased.*

TILE DRAINAGE.

The ideal form of drainage, in order to obtain all the benefits enumerated, is underdrainage, and the ideal form of underdrainage is tile drainage.

"Tile drainage consists of tiles laid at proper depths and intervals, of sizes sufficient to carry away all water coming to them before the soil would be injured by saturation." Tile may be made of burned clay or concrete.

CLAY TILE.

Clay tile may be either soft or hard, burned or vitrified. The hard burned or vitrified tile are the most durable because they are stronger and the walls are less porous, thus being better protected against frost action. The drainage efficiency of tile is not affected by the difference in porosity of the walls. The walls of a porous tile will absorb water quickly until saturated, but, beyond that, no appreciable amount of water goes through the walls. The conclusion has been reached by experiment that the porous property in tile has no value for draining. *The water enters the tile through the joints.*

CONCRETE TILE.

Concrete tile has come into use in more recent years and is extensively used in the middle west. If properly made it is probably as good as clay tile. On account of the newness of concrete tile for drainage we do not have the basis of long continued use to determine their adaptability, as we do in the case of clay tile. Failures have occurred, but so also have they in the clay tile. Some of the arguments made in favor of concrete tile are: That it is more smooth and uniform in shape than clay tile, and that because of its porosity water will pass through the wall of the tile and hence drain the land more thoroughly, but as has just been stated, the results of experiments with porous clay tile show that the porosity of tile is of no value in underdrainage.

With concrete tile, what failures have occurred have been due to aggregates of poor quality, poor or ignorant workmanship or improper treatment in the process of manufacture. The leading manufacturers of cement recommend that tile be made of a rich mixture and be as non-porous as possible. A porous concrete tile, as a general rule, is evidence of weakness. It is difficult to make satisfactory concrete tile on the farm because of the lack of adequate facilities. The best place for them to be made is in a factory, where all the facilities for proper mixing, molding and curing of them are at hand. Special care should be used in curing the tile, as a well made tile may be ruined by improper curing. Particular attention is called to the fact that a good quality of sand should be used, a fact which is often overlooked by the average farmer. Sand for concrete tile should be both fine and coarse up to one-fourth inch in diameter, and it should also be clean and sharp. The average fine, water-torn sand of the Coastal Plain Region, is not suitable for concrete tile, in the writer's opinion. Compared with clay tile, its cost if properly made at a factory, has not been much lower than clay tile in North Carolina.

ARRANGEMENT OF DRAINS.

The arrangement of drains is determined largely by the topography of the land, although for level land there are several recognized systems which are more or less closely followed by drainage engineers. In general, the main should take the same general location and direction which the water takes, in the wet time, to get off the land. Laterals should be made in straight lines so far as possible, and straight down the slope. On comparatively flat land the laterals should generally be arranged in more or less parallel lines at such intervals as will accommodate the soil. Short mains with long laterals is one of the most economical arrangements, if it can be secured. Every main and submain drains the land a certain distance each side of it, and the laterals passing through this portion are of no service to the land; in other words the land adjacent to the mains is double-drained. If possible, have the laterals discharge into the mains on one side only. Make one main serve as many laterals as possible, so as to avoid an unnecessary number of outlets, which always require more or less attention.

While all the above arrangement of drains cannot be followed in most cases, and will have to be modified more or less by local conditions, yet it is well for the farmer to keep them in mind, if he wishes to secure the most drainage for the least cost. Above all things, do not install your tile haphazardly, but plan your whole system first, and then install such portions as you see fit, adding to it later on, so that they will ultimately form links of a completed system. If this is not done, much of the money first expended may thereby be thrown away.

THE DEPTH AND DISTANCE APART OF DRAINS.

The depth and distance apart of drains will be largely determined by the texture of the soil. With regard to depth of drainage, Elliott states that 4 to 4½ feet is called deep, 3 feet medium, and 2 to 2½ feet shallow. The proper distance apart of drains is a subject that is closely related to their depth. We have spoken of how the ground water level is lowered between the lines of tile, in a curved line, the highest point being midway between the drains and the lowest point directly above them. The distance apart and depth of tile should be such as to reduce the ground water level between the drains to a point most beneficial to plant growth, within about 24 hours after the ground has been saturated.

In sandy land the drains may be placed deeper than in clay land, and with an increase in depth spaced wider apart. In clay land an increase in the depth of tile will usually not permit an increase in the interval between drains, because of the sluggishness of soil water movement in clay soils, which will cause the water table to be lowered too slowly to be of benefit to the crops.

In North Carolina, except in the stiffer soils, like pipe clay, etc., for general field crops, an average depth of 3 feet for laterals will usually give good results. A spacing closer than 60 feet makes tile drainage so costly that it is not recommended, except on valuable land. A spacing of 100 feet is giving good results in portions of the Coastal Plain Region.

As a basis for the proper distance apart of drains, Elliott states for the different types of soils—in close, dense soils, 30 to 40 feet; in clay, loam and sandy clay, 60 feet; in sandy loam soils, 100 feet; in gravelly soils, 150 to 200

feet. For trucking crops a closer spacing is necessary than for general field crops.

GRADE.

A very small grade will suffice for the flow of water in tile. Tile drains will operate on a grade of a half inch per 100 feet, but a fall of 6 inches or more per 100 feet is much more desirable. The less the fall the greater the precautions that must be taken in the construction work and relatively larger tile must be used.

SIZE OF TILE.

The size of tile will be determined largely by the area drained, the grade, the texture of the soil, and the amount and intensity of the rainfall.

The size of the tile increases with the area drained by that tile, thus drains spaced far apart need to be larger than drains placed close together.

The size of the tile decreases as the grade increases, since the quantity of water a tile can carry is the product of the cross-sectional area of the tile and the velocity of the water. The velocity of the water is greater with a steep grade than with a flat grade. Hence if the grade is decreased the cross-sectional area must be increased.

In general terms, tile drains need to be larger in a soil of open texture than in a dense soil, since the water passes through the soil to the drains faster and the tile must be capable of carrying off this water. For ordinary crops the size of the tile should be such that they will be capable of removing surplus water from the surface of the ground within thirty-six hours, or better, within twenty-four hours. In regions of intense and large rainfall, taking into consideration the climate and season of the year in which they occur, of course, and where unusual storms may be expected, the size of the tile should be larger than in regions where the rainfall is small or normal and not subject to heavy downpours.

Where the annual rainfall is thirty-five to forty-five inches and under standard conditions of climate, surface and soil, it has been found that satisfactory drainage can be obtained if the mains are designed large enough to remove one-quarter inch in depth of water from the area drained in twenty-four hours. In some sections of North Carolina, the annual rainfall amounts to from forty-five to sixty inches, but the climate offsets to a large extent the damaging effect of this large rainfall, and what systems we have installed have been designed to remove a runoff of one-quarter inch in depth of water in twenty-four hours and appear to be giving good drainage. According to the records of the Weather Bureau, July and August are usually the wettest months of the year, and yet it is those very months in which droughts occur. Evidently the plants and evaporation play quite a part in taking up a considerable portion of the water. If this be the case, then it seems proper to use the one-quarter inch runoff until further investigations warrant a change.

No attempt should be made to make the capacity of the mains equal to the combined capacity of the laterals. Tile less than four inches in diameter are not recommended, especially where the grades are low and the soil more or less sandy, this because of the danger of the smaller sizes becoming clogged with silt.

CONSTRUCTION OF TILE DRAINS.

Unless the area is large, a series of surface elevations along the lines where the drains are to be laid will be sufficient to determine the grade of the drain.

The first important requirement for the successful making of a tile drainage system is to have a good outlet. A free outlet should be obtained whenever possible; that is, the water from the tile should discharge above the water level in the outlet ditch or stream. At the outlet a headwall of stone, brick or concrete should be made, so that the outlet pipe will be held in place and the bank protected from caving. The lower ends of the mains for a distance of ten feet from the outlet should be constructed of sewer pipe or iron pipe and the joints should be cemented. The end of the drain should also be protected by wire screening to prevent the entrance of small animals or trash.

The ditches are usually laid out by pairs of stakes, one a guide from two to three feet long and about four inches wide, on which the station number and depth to dig are given, and one a small square stake driven flush with the ground upon which levels are taken, and from which all measurements are taken. The ditch is dug at a distance of about ten inches to one side of the line of stakes. A narrow ditch is the most economical because less material needs to be removed, and a width of twelve inches on top will be wide enough for a ditch three feet deep. After the ditch is partly dug, place the grading line in position, setting it a convenient height above the surface, and at a constant distance above the bottom of the proposed grade line. Then by the use of the grade stick of the required length, which length is the distance below the line to the bottom of the ditch, the bottom may be graded. It is very important that the bottom of the ditch be made smooth and uniform with no sags in the line.

Small systems are usually dug by hand, and the tools necessary for this, outside the regular shovels, are the ditching spade and the tile scoop for preparing the bottom. Start the ditch at the outlet and work up grade.

The tile may either be laid by hand or by a tile hook, if small sizes are used. Begin at the outlet and work up grade. If the ends are not square, let any opening come at the bottom and cause the tops to join closely. Openings of one-quarter inch or more should be covered with broken pieces of tile or a dab of cement. Curves may be made by either chipping one side of the tile or by covering the openings with cement or broken pieces of tile. In making junctions use the "Y" joints, which are special pieces made by manufacturers. Drains should join at an acute rather than a right angle.

As soon as the tile are laid they should be fixed in place by blinding, which consists in placing moist earth from the sides of the ditch at the sides and top of the tile, for a depth of about six inches. The ditch can then be filled in by shovels or by using team and scraper.

COST OF TILE DRAINAGE.

The cost of tile drainage varies greatly, depending on the nature of the soil, presence of stone and roots, the spacing, the depth, size of tile, season when done, method of construction, and the local labor conditions. For six-inch tile or under, in this section, the cost of digging the ditch, laying the tile, and blinding and refilling ought not to exceed nine cents per linear yard

for a ditch three feet deep. The cost of tile ranges from twenty dollars per thousand feet for four inch to forty dollars per thousand feet for the six-inch in car lots, f. o. b. at the factory. With freight added, these prices will ordinarily be twenty-five and forty-five dollars respectively. For sizes larger than six-inch the tile manufacturers in this section usually sell No. 2 sewer pipe, eight-inch costs seven to eight and one-half cents per foot, ten-inch, eleven and one-half to thirteen cents per foot, twelve-inch, fifteen to seventeen and one-half cents per foot.

With the above prices and assuming an acre of land to be drained with four-inch tile, the cost will range from sixteen dollars for tile spaced one hundred and fifty feet apart to forty dollars for tile spaced sixty feet apart. To this cost must be added the cost of larger mains, hauling of tile from depot to the farm, and cost of accessories like silt-wells and headwalls. Also, add to this the cost of the engineering, which is variable.

Hence it is evident that the drainage of farm lands is not an inexpensive operation. The exact knowledge of this cost does not mean much to the farmer, unless at the same time a fairly accurate idea of the profit to be expected from drainage can be given him. It might be well to state here that all land does not need systematic, regular systems in which case the average cost per acre may be reduced to \$10 or \$15.

The extent to which tile drainage has been practiced in North Carolina is not such as to bring before its inhabitants in general the far-reaching importance of it. Considerable tile has been laid in the draining of ponds, swales and springs, but not very much systematic drainage has been done. For this reason, we must draw, to a large extent, from the experience and records of both cost and benefits in Iowa, Illinois and other States in the Middle West. Fifteen years ago, there was probably no more interest in underdrainage in that section than there is in North Carolina at the present time. There seems to be no doubt but that the installation of tile in the South pays just as large or larger returns than in the Middle West, and as the population becomes greater, underdrainage is going to be more extensively practiced. As the country becomes more densely settled, there is going to be an increased demand for land, and as the price increases it will become more and more profitable to drain our wet farms.

There is an impression that our Southern lands are too low in price to pay us for this expensive work of tile drainage, but with the high prices that all farm products command today and the numerous markets within reach of the farmer, it seems that it would pay to underdrain all land where there is the least chance for a failure or partial failure. This would apply especially to truck crops. Why not put our lands in such a shape that they can be depended upon to produce "bumper" crops each year? Underdraining our "cheap" lands will be one of the means of getting rid of their cheapness and they will become valuable.

One of the reasons why tile drainage is not practiced more here in North Carolina is that the great results of underdrainage are not generally understood. Another is that the critical operations of putting in a tile system are even less understood than its benefits, and farmers believing that it is more difficult than it really is, fearing to make a mistake, leave it alone.

The average farmer feels that he can not afford to drain as the cost is too great. Dr. W. I. Chamberlain in his little book on tile drainage answers the

question, "When can we afford to drain?" in this manner, "*We can not* afford *not* to drain if we have land that we need for tillage and rotation, and which is naturally unfit for it, but which can be fitted for it by tile drainage. Shall we wait till we are out of debt and have money to tile it, or shall we tile it in order to get out of debt? The latter as a rule."

Tile drains, properly installed, are a permanent investment, and very little maintenance is required. The increase of from six to ten years crops will usually pay for the cost of drainage, after which the increase in the crops caused by drainage is an annual profit for an indefinite time. Underdrainage is becoming more popular in North Carolina and from present indications the writer looks to see the most extensive work of this character that is done in the United States during the next ten years carried on in this and other Southern States.

At the close of the afternoon session the delegates were carried in automobiles to see a practical demonstration of tile drainage by Mr. J. C. Cowley.

At eight o'clock in the evening an informal reception and smoker was given the delegates by the citizens of Wilson at the Commonwealth Club.

MORNING SESSION—Thursday, November 19

At nine o'clock the delegates assembled at the Briggs Hotel and went to a tobacco warehouse where they witnessed a tobacco sale.

The morning session was opened with prayer by Reverend A. W. Cheatham, Rector, St. Timothy Episcopal Church.

The President read the following telegram from Mr. M. V. Richards, Land and Industrial Agent of the Southern Railway, who had been expected to make an address to the Convention.

Am very sorry it will not be possible for me to attend meeting of your Association tomorrow, November 18. Must go to Southern Georgia. Greatly interested in your aims. Best wishes for splendid convention.

(Signed) M. V. RICHARDS.

Washington, D. C., November 17, 1914.

The first paper read at the Thursday morning session was by Mr. C. W. Mengel, Drainage Engineer of the John L. Roper Lumber Company, of Roper, Beaufort County, North Carolina, on "The Drainage and Development of North Carolina's Muck Lands."

The Drainage and Development of North Carolina's Muck Lands

BY C. W. MENGEL, DRAINAGE ENGINEER.

It has been thoroughly demonstrated during the past few months that of all the various pursuits engaged in by mankind, that of farming, where each farmer produces on his farm all the products necessary for the maintenance of his family and his stock, and still has a surplus to place on the market, is the most independent, and is the surest basis for general prosperity.

At this time when the "back to the farm" movement is being agitated, and when without a doubt many who have left farms for the city, or were seriously considering that move, are coming back to the farms—it is indeed fortunate for North Carolina that within her boundaries there are hundreds of thousands of acres of the most fertile soil as yet untouched by the plow. I refer to the black muck lands of the coast section.

This type of land can be found bordering the Atlantic coast from the Virginia line to the southern boundary of this State, and the larger tracts are usually found at an elevation below 25 feet above sea level. Except along rivers, creeks, and their headwaters, the soil, as indicated by its name, has been formed primarily from decomposition of water plants, sphagnum mosses, and sedges, and as these decomposed they gave way to a timber growth of cypress and gum. Along the rivers and creeks bordering this formation, the soil is more alluvial in origin, and more firm in character. From these water-courses, which are naturally at the lower elevations, the soil becomes looser, and the deposit of muck becomes deeper, as the elevation rises. This deposit varies in depth from one to seven feet, and the muck is rawer or less decomposed, in the spots of the highest elevations.

On account of the fact that these lands were formerly covered with valuable timber, and also on account of the lack of faith in the quality of the soil, they have not until the last few years been subdued, and a start made to make them productive, agriculturally. Before they can be made a source of profit to the owners, the railroads, and before they can add any revenue in the form of taxes to the State and community they must be drained, developed, and settled by a good class of citizens.

DRAINAGE.

To produce the most lasting, and, consequently the most satisfactory results the development of our muck lands should be carried on in a comprehensive and thorough manner. Because of the fact that the natural wetness of the lands is the first barrier to reclamation it might be said that drainage is the most important step in the development process. Inasmuch as the lands are tributary to some river or creek, their drainage should first provide an outlet through this natural channel. This outlet should be so designed that whether or not the entire watershed is taken into a single Drainage District at one time, its capacity will be sufficient to remove all surplus water from the entire watershed, when it is ultimately organized into a district and drained. In order to accomplish this a careful survey of the entire watershed should precede any construction work. It can aptly be said that an "ounce of prevention," taken in the form of accurate survey data, will save "a pound of cure" from the troubles of shortsightedness. Whether or not all the land in the watershed is organized into a district at one time is, then, immaterial, and each district (if there be more than one) may proceed to completely drain the land within its boundaries by a uniform system of drains, inside the main drainage district. That right to perfect a drainage scheme by organizing one district within another has been upheld by a late decision of the North Carolina Supreme Court.

Experience in draining muck lands of other states has been that in order to secure adequate drainage for these lands, the main canals must have an effective depth of from seven to eight feet, and a dividing distance laterally

of not more than one mile. This experience has been paralleled thus far in the draining of North Carolina muck lands, and as a rule it might be said that the course is a safe one. These main canals which are tributary to the outlet or trunk canal, should be laid out uniformly, and in most cases they can be made parallel as the topography is quite uniform and will permit. This plan of uniform spacing of mains has the advantage in making equitable drainage assessments easier, and the land can be subdivided into uniformly shaped tracts where each form will have like advantage as to drainage and proximity to good roads, in case development for sale is the object.

The muck lands of North Carolina are underlaid with both sand and clay subsoils; these subsoils are found in different localities, and, as far as the quality of the top soil is concerned, no difference is found between that underlaid with sand and that underlaid with clay. With a properly controlled water-table, by means of properly spaced open drains, and tile drains, both are water-absorbing and drought-resisting to a remarkable degree.

The proper spacing which should be given to lateral drains in this soil is as yet an experiment as far as any exact knowledge is concerned. Practice in this regard in Eastern North Carolina varies from a minimum spacing of 330 feet to as high as 660, depending upon the crop and the degree of rawness of the soil. It is the opinion of the writer, however, that in order to guard against extremely wet years the spacing on ground where a variety of crops is raised, should not exceed 330 feet for either open or tile drains. It is highly probable that as the muck decomposes more and more the spacing of the laterals will have to be made closer.

While the muck is loose and contains more or less raw vegetable matter, the ground should be kept fairly wet and the water table high, as the extreme porosity of the soil at this stage does not give it a high capillarity. During this stage long-rooted crops should be the major crop, as they are less liable to suffer from a prolonged drought. The laterals, therefore, should not be deep at the start, and until the ground has been cultivated a few years, a depth for the laterals of more than three and one-half feet is not recommended. Experience elsewhere has shown that muck lands have been irreparably damaged by a lowering of the water table below the subsoil, followed by a very dry season. If properly handled at the start this difficulty will vanish, after a few years of cultivation.

Whether or not tile should be used at the start, as laterals, is open to more study. It is the opinion of the writer that tile can safely be used, if laid on a firm subsoil and arrangements are made by which the tile may be closed during periods of drought, thereby controlling the position of the water table. These muck lands when properly subdued and thoroughly drained can not be injured by any rainfall, as their storage capacity is very great, and on the other hand this same quality gives rise to a high capillarity which makes the most drought resisting soils.

DEVELOPMENT

The drainage of the lands having been accomplished the next step is their development. In this step the building of a system of good roads comes first. No argument is needed to prove this, for good roads have always been the forerunner of development. The system of roads must be designed to give every individual tract of land an outlet to the main highways. One part of

this system can be made easily by levelling one spoil bank on each drainage canal, which with proper working with a road machine will give a good solid, sand-clay road with perfect drainage. This can be done at a cost of from \$400 to \$600 per mile, or for a road on a minimum sized dredged ditch at an extra cost above the cost of excavation of from one and one-half to two cents per cubic yard of excavation. Cross roads at right angles to these can be constructed by ditching each side of the road, and scattering the excavated material in the center, there to be worked to proper shape by a machine. The roads of this type can be built for about \$800 per mile. If these roads are placed at mile intervals we will have a tract of one square mile, surrounded by a good road, and with perfect drainage facilities. The cost of these roads will amount to slightly over two dollars per acre to the land served.

The preparation of the muck lands for crops varies with the growth on the land. This is of two kinds—timber and reeds.

In order to make a crop the first year on the land on which timber is growing, corn must be raised. This is done by what is known as the "stuck" process, which consists in cutting the growth in the fall, burning it in when thoroughly dry in May and immediately thereafter sticking the crop among the stumps and logs. This process may continue for as long a period as four years, when the stumps and logs not burned are gathered and burned, and the land is ready for cultivation. By this process land may be cleared and the owner may realize a profit from the crops raised during the period of clearing.

The reed land must be cleared and cultivated at once, and though the initial cost is more than for a stuck crop on timbered land, there is the satisfaction of being able to cultivate it and raise on it a variety of crops.

The costs of these methods of development and the profits realized thereby have been discussed in a paper by Mr. J. O. Wright at the First Annual Drainage Association, and will not be dealt with in further detail here. It might be added that the first man to see the possibilities in draining and developing large areas of North Carolina muck lands was Mr. J. A. Wilkinson, an enthusiastic member of this Association, and the work done by him in the Pantego and Broad Creek Drainage Districts is a revelation even to the people of this state, who never dreamed of such fertile lands lying at their very doors.

The introduction of machinery into land-clearing operations has simplified a great many problems, which heretofore have seemed insurmountable, on account of the amount of labor involved, and on account of the cost being so high that the selling of the developed land at a reasonable figure was prohibited. As yet there are very few machines on the market for land clearing purposes, but progress is being made, and we can be assured that with the vast amount of unreclaimed land waiting to be cleared economically, machines will be perfected which will enable the work to be done more cheaply than formerly, and the lands can be put on the market at reasonable figures.

These lands, once developed, must either be sold to American farmers or be colonized by some thrifty foreign element. The former would be more desirable, but in either case these must be colonization from other parts.

To carry on this work of development requires a great amount of capital. The drainage costs can be covered by bonds issued under the authority of

our State Drainage Act. The development costs must come from another source, and financiers must be convinced by actual facts that money spent in development of our muck lands is a gilt edged investment. That there are a great many superstitions prevalent in the minds of outsiders as to the desirability of the lands and the healthfulness of the climate in the muck land section there is no doubt, and these rumors, coupled with an ignorance of actual conditions by a majority of people, will make it difficult, no doubt, to finance these projects until a more advanced stage is reached.

When the lands are developed the people sought after for settlers must be convinced (if we will reach the better classes) that they are to have the advantages of good health, good schools and churches, and that they will be welcomed as a part of North Carolina's citizenship.

Reports From Representatives of Drainage Districts

At roll call the following districts responded:

Broad Creek Drainage District of Beaufort County has been completed.

Conaby Creek Drainage District of Washington County has been dropped for the present.

Pungo River Drainage District of Beaufort County has been practically completed, with the exception of about one and one-half miles of widening the main channel at the lower end. (Report made by Mr. Mengel.)

Lyon Swamp Drainage District of Bladen and Pender Counties. Mr. Keith reported on this district as follows:

The district was finished about three or four years ago and has proven a wonderful success not only in the way of drainage, but it has put new life into the entire community and health has been perfect, you might say. Lands that were formerly woods are today very valuable—in many instances ten times as valuable as they originally were. We are producing all classes of crops there—corn, cotton, oats and wheat—we raise fine wheat there, also hay, peas, potatoes, and now we are just on the beginning of a new year of greater prosperity than that country has ever dreamed of. We are trying for good roads now, and when we get our good roads, with our good lands and our new school buildings (we have twenty new graded schools established), which are as great a stimulus to drainage work as anything else, we can say ours has been a great success so far and I have no idea but what it will be greater.

Moyock Drainage District No. 1 of Currituck County. Mr. Brett reported that the drainage district was finished and the land under cultivation.

Mattamuskeet Lake Drainage District of Hyde County. Mr. Chappell, engineer in charge, reported: About 40 per cent of the excavation work has been completed, and also about 22 or 23 per cent of

the mile of ditches. It will take eighteen months to complete the drainage. The erection of a pumping plant will begin in about two weeks and so far we have been very much pleased with the progress of the work, and the indications are for success. We have had less difficulty than we anticipated, and this was easily overcome.

Rocky Point Drainage District of Pender County. Mr. Beeton reported that the work had gone on very slowly on account of rock encountered, but now it is practically complete and a good deal of land is ready for cultivation.

Parkville Drainage District No. 1 of Perquimans County is about 60 per cent completed and will be finished about the first of February.

Back Swamp and Jacob Swamp Drainage District of Robeson County. Mr. Sellars said that out of a total acreage of 35,000 about 95 per cent had been completed. The work had been very satisfactorily done so far and they expected good results.

Pitt County Drainage District No. 1 of Pitt County. The surveys and engineering features have been closed up. The people are anxious for the drainage.

Wayne County Drainage District No. 1. The work has not been completed on account of lack of money—about \$6,000. This district has been an incentive to the organization of other districts throughout the county.

Wayne County Drainage District No. 2. The length of this district is about thirty miles and estimated acreage seven thousand. This district was started about ten years ago by correspondence with Governor Aycock. There are no legal objectors in the district. The next thing to do is to sell the bonds and get a contractor to do the work.

Wayne County Drainage District No. 3. Major Peirce. This district is about ten miles long and contains about three thousand acres. No objection has been filed on account of three of the largest landowners. When you have two or three big landowners objecting to it and they have money to employ lawyers to fight this drainage law and resist every move you make, you had better use a little diplomacy and get that fellow to go in friendly before you file the objection. Last week I spent one-half a day with a man trying to persuade him to come in, and he said: "Do you know whether that land will be helped? Suppose we wait two or three years and watch some of these districts that have been completed and see if the fertility will be increased. It has been soaked so long in water that I think the bottom will drop out and nothing be left to it." Of course I told him the fertility of the land would be greatly increased.

The President of the Association made a plea that the drainage dis-

tricts be named according to the county in which they were organized and in order of the organization; as for instance, Wayne County Drainage District, No. 1.

Following the discussion of the drainage districts Hon. John H. Small, of Washington, N. C., made an address on "North Carolina Drainage Law and Some Needed Amendments."

North Carolina Drainage Law and Some Needed Amendments

BY HON. JOHN H. SMALL, CONGRESSMAN FROM FIRST NORTH CAROLINA DISTRICT.

Mr. President and Gentlemen:

I am going to ask you to let me browse about a little this morning, and not confine myself to North Carolina Drainage Law and Some Needed Amendments. Amendments to our law, just as the original draft, require very serious consideration. We cannot discuss them in a proper way—and certainly you cannot frame them in a way which will make them legal and consistent with the existing drainage law. I see in the morning papers that there was some discussion yesterday of needed amendments—one of them by my neighbor, Mr. P. H. Johnson, of my own county. I believe that the subject of these amendments ought to be considered by the committee who will give to it sufficient of their time, directed by an intelligent study of the law, and that they shall have the coöperation of the practical men connected with the drainage of our wet lands; because the actual putting to a test of any law, as in the drainage of lands, reveals its weakness, the points of amendment which are required and the strengthening of it in order to make it more effective.

While I have several points in mind, there are two or three which are particularly necessary, as coming under my own observation. One of them is the lack of any provision in the law for transferring the tax from the grantor to the grantee. Now there ought to be a provision of law by which the grantee of that one hundred acres shall know and shall become bound for the burden of the payment of the annual assessment, arising out of the transfer of ownership. That has arisen very frequently in the districts in some of the lower counties where lands reclaimed were owned by one person and transferred to another, and in many instances the reclaimed lands had not been previously under cultivation. My friend, Mr. Johnson, I have heard speak a number of times about increasing the tax at which land should be valued. I do know that in some instances viewers have said as to a certain piece of land that you cannot benefit it * * * that it would not be as much benefited as another tract of land which he had placed in the lowest class, and yet it ought not to escape entirely its burden, because it will receive some benefit. On the other hand, lands which are greatly benefited and placed in the highest class are not as greatly benefited, or are a little less benefited, as some lands which also are receiving or will receive the highest benefit by the process of drainage. So that I think an enlarging of the number of classes for the division of land and classifying the benefits might well receive the attention of the Legislature. I am not going to detain you longer to talk about amendments. I had the honor of being in some degree responsible for the drafting of the original law of 1909; in fact, I took a lot

of rough material and put it in shape; and in that shape it was enacted by the Legislature. I also spent some time, more than a week altogether, over the preparation of some amendments and sent them to the Legislature of 1911. Some of them were discarded, which I think were valuable and might well receive the attention of subsequent legislatures. I mention that point, not in any spirit of egotism, because I have done no more to serve this important movement than many others have done, and are willing to do, but because I do wish to emphasize the point that these amendments must receive careful consideration from two sources; practical men connected with drainage of the lands and at least one or more good legal minds who will see to it that the amendments are consistent with the existing law and in themselves shall be entirely legal and workable.

I am willing, Mr. President, to assist in this, for it shall be my pleasure, and the pleasure of the Drainage Association, to coöperate with the committee which will endeavor to frame the necessary amendments to be presented at the next session of the General Assembly.

Now, Mr. President, I want to do that browsing for which I asked permission, and to talk just a little about this general movement for drainage. We hear and we read a great deal about progress. We refer to it in connection with certain communities as being progressive sections. One state is making progress more rapidly than another state. We refer to our great country as the United States, describe the progress it has made, and its comparative relationship to other countries. The world for twenty years has been talking about the progress of Germany, which has really been wonderful, but while the press as noted in our current literature, our newspapers and periodicals, is largely concerned with this question of progress of nations and states and countries, you cannot separate progress of the state from the people who live in these communities and who constitute the citizenship of these states and plan their government. While natural resources are greatly to be desired, while the different sections are to be congratulated on their topography, their soil, their climate, their forests, or their mineral wealth, some offer advantages which are not possessed by others; yet after all the proposition may be laid down without the slightest fear of contradiction that no matter to what extent any section of country may be blessed with all or part of these natural resources, unless the right kind of folks populate that community and these sections of countries, these natural resources will not count for progress. I feel that we may this morning indulge in self-congratulation in that we are coöperators in a line of work which makes for genuine progress.

It takes many elements and factors for a complete civilization. We are proud of the churches; we take great pride in this propaganda which we have urged so consistently for the upbuilding of our public schools, so that every child, no matter how humble his birth or parentage, may have the advantages of a common school education; we have reached that stage in this state where we believe that every boy and every girl is entitled to a chance. So, we are proud of many other movements which make for higher ideals, for better morals, for a clearer spiritual insight into ourselves and into others, and into problems which increase and widen our horizon. Yet, after all, it is the material progress which a people make which must be a forerunner to every other variety of progress. You cannot progress unless these resources are utilized and developed for the well-being and up-building of humanity.

While one of the apostles said it was through the foolishness of preaching that men may be saved, yet even the churches must be supported, and no community will find it possible even to maintain a good church which will properly serve the Master without a spirit of coöperation.

I do not know how it impresses you, but, as a boy, and frequently since then, I have tired of the premium which is too frequently placed upon poverty. I have heard too many good preachers talk as if poverty was the one true, unerring road into Paradise. If it is necessary for a person to be poor; if in spite of the utilization of the best intelligence and talents of a man or woman, they are poor, they should not be criticized; but poverty, when it is due to ignorance, narrowness, want of capacity or lack of ambition to improve the opportunities which they may have, instead of being an object of merit, it is an insignia of disgrace and it does not fit any man better to serve the churches or to serve himself or to travel in the straight and narrow way. You cannot separate the material progress of a people from their general progress, because all these movements which make for higher ideals in life, must have as a concomitant contemporaneous with them a people who are progressive along material lines in order to give force and fact to this spirit of moral ideas. As we go along progressing, as we get from time to time the finer type of civilization, the individual as an individual becomes of less relative importance and the individual in his relationship to other individuals becomes of greater importance, because the finer the civilization of a community or state, the more is coöperation needed between these individuals in order to bring about the welfare of the people. For many years, in fact, for a century in North Carolina, as I read our history, we have emphasized individualism. Perhaps that was right in the early days when the dominant thought in the minds of the people was the construction of our basic laws, the preservation of individual liberty pointing constantly to our Magna Charta. The fact that during that earlier period men could more nearly live alone than they can today, perhaps from necessity and the natural training of conditions, it was altogether proper that the individual should be emphasized during that period; but for some years we have been gradually approaching that condition where the very best things for our welfare and happiness and contentment and prosperity require that men and women should join hands. It is true we must have leaders in every movement, but for a man to lead, whether it be in the church, in the good roads movement, in politics, or any of the activities of government, that man cannot lead until he has first learned to serve. I do not quote it literally, but there is something in the Good Book substantially like this: That he who would be chief among you, let him first learn to serve. It was said by one of the Governors of Massachusetts on one occasion that he considered one of his greatest successes in life was due to the fact that he had learned to work singly and in harness. And I say that every man who would be a constructive leader in his community and stand for the things that are righteous and make for individual and community welfare must first have incorporated into the warp and woof of his being the spirit of service to others; because a man who has not learned that cannot lead others in a coöperative movement in which all are engaged in a common service unless he himself knows how to serve. One of the difficulties of every movement which is inaugurated for the common welfare and in which each individual is interested is in obtaining their

coöperation. Every one knows about that wonderful movement for public education which has now been carried on in our state for a number of years; how difficult it was to get our people away from the idea that it is the duty of each parent to look after the training of his own children, and that he had no duty towards his neighbors! How difficult it was to get men to understand how at the base of that idea of public instruction was getting him to be willing to work together with his fellows and provide school facilities for all of the children.

We have had bad roads in North Carolina for a hundred years, but under the leadership of progressive citizens representing the communities and counties we are making wonderful progress in improving our highways, and this has been accomplished under the greatest difficulties. It has been done by impressing upon the people in the townships and counties, which are the proper unit—I say in impressing upon the people of the townships and counties—if we would have good roads it is the duty of every one to contribute in proportion to the extent with which he has been blessed his quota for the construction and maintenance of good roads. It is true, as in all other undertakings, a great difficulty was encountered in the ignorance of the people. Ignorance constitutes the barrier which blocks the way to improvement and progress in every direction. The main difficulty after you have convinced a man of the need of a certain improvement, after he has gotten at least a working idea of the method by which that improvement shall be brought about; the great barrier which has been confronted in every instance has been the difficulty in convincing him that he must join hands, and work together, in sympathy, with intelligence and in charity, with all others who are willing to engage in a common undertaking with him.

Now I said we are to be congratulated in being in attendance upon another annual meeting of the North Carolina Drainage Association. It is not the only pebble on the beach among the constructive movements in North Carolina, but there is scarcely another which is of greater importance. We are taking an asset of comparatively no market value, of no productive capacity, or the productive capacity of which has been greatly impaired by conditions, the conditions being the presence of too much water; and we are adding double, treble, and four-fold to the value of that asset because we are increasing its productiveness; and, if this Association and its friends and co-laborers in North Carolina shall continue to stand together, having as their ideal the drainage of all the wet lands in North Carolina, with the intent that they shall be so effectively drained that they will make good crops every year, it will have added to the wealth and profit and welfare of the people of North Carolina I believe more than any other one movement in this great march of material progress in which we are engaged. Coöperation is the prime factor here. I was very much interested a moment ago in the statement of Mr. Peirce about the several drainage districts of Wayne County. His report was a reflex of that which has occurred in every other drainage district. He spoke of the difficulty of getting uniform agreements among the landowners of the drainage district and of the inadvisability of pushing them too hard until you had exhausted every effort to convince the doubters, the skeptics, the men who hold back that it is their duty to join in the establishment of such a drainage district. That simply illustrates that one of the reasons why there are so many hundreds of thousands of acres of land in North Carolina, so

many of which are not in cultivation and some of which have not been in cultivation for a century or more, have never during that time been efficiently drained and have every few years, according to the common expression, been "drowned out." That very difficulty explains that condition here in North Carolina because in the past our individual landowner has claimed the privilege and the right and the power to drain his own land, regardless of his neighbor. It is true, you must realize that it is impossible for the individual to drain these lands by himself, and so we have had ditch laws enacted by our legislators from time to time; but their very inefficiency has been proven time and again by the fact that through them we were not able to drain land in any economical manner, and it is because we realize that the individual landowner as the unit in the solution of the problem of drainage will not drain our wet lands in North Carolina that our Legislature, at the insistence of some of our people, have enacted the present drainage law which has enabled us to translate into action this disposition of the people to coöperate and to drain their land along with their neighbors' land, because it was impossible to do otherwise.

I know, Mr. President, that this is old; I know it is a truism to talk about the necessity of coöperation; I know that each man will say that he appreciates the duty he owes to his fellows; and yet, as a matter of fact, other intelligent men here know that this barrier still exists as a bar to the more rapid progress of the drainage movement, and that the nearer we come to striking down this barrier and creating in the minds of owners of wet lands in North Carolina that it is their duty to join with their neighbors, their contiguous landowners—the nearer that is done the more rapidly will we advance and the more drainage districts will we organize.

I go about among the people on the farms at every available opportunity. I love to do so, because you can become better acquainted with a man by his own hearthstone and understand his life better in the presence of his family and he will come to know you better than under any other circumstances. I think I know the people of eastern North Carolina in a number of our counties, and their many characteristics. There are no finer people to be found anywhere than here. They have inborn in them the spirit of charity and benevolence. I doubt if there are any people in the world who, in the presence of sorrow, suffering, disease or death, can be appealed to with the assurance of a more generous or ready response than these people of eastern North Carolina; and I think I can speak for the whole of the state. And yet, as a rule, if there is a public question affecting our whole state, I realize that our people to a degree are narrow and constricted in their views, and are sometimes lacking in the generous spirit of coöperation with their neighbors; are distrustful when it comes to joining hands for the success of a movement and that too frequently all of their good qualities are forgotten in the solution of these public questions. The citizens of communities and counties of the state at large need to cultivate this spirit of kinder service in coöperation, which can only operate to their good. I believe, taking each one of us separately, we wish to do all in our power to further this drainage movement, taking it for granted that in our respective communities we are willing to get behind any movement for the public welfare; and I do not believe that we can accomplish a higher service than by constituting each one of ourselves as missionaries to go abroad among our people to preach this doctrine of

coöperation, each in his own community, and to show them by our daily lives the generosity which should animate such a spirit. And then, in so far as we can, preach the gospel of service to the people among whom we live. That is the great thought I had in mind, Mr. President and gentlemen of the Association. I hope that the life of this Association will be indefinite. I hope that so long as there is an unreclaimed area of wet land in North Carolina that this Association shall be an active force for its drainage, remembering as we must do that not only should we drain the unreclaimed swamp lands and timber lands which have been cut over; but that there is a very large aggregate of land which has been in cultivation a number of years and which has its value impaired because it has not been properly drained. So long as unreclaimed lands are undrained this Association will continue its activities, to the end that the ideas of the Association shall be carried out.

Just this thought, and I will not trespass upon you longer. Not only is the drainage of our lands necessary in order to make them more productive, but I am sure that I will not bring you any new thought when I say that drainage of these lands is necessary in the conservation of the health of our people. I was born and have always lived in eastern North Carolina. It is a section of the state which has always been regarded as unhealthy. I was talking with a young lady in my town yesterday who said she was born in Rockingham and her people were very much averse to her coming down to the low country. Part of this fear is justified and part is unjustified. But you can kill a man by frightening him almost as successfully as you can by bludgeoning him, and this dread of malaria in eastern North Carolina among those who live in a higher elevation or those who come from other states has been one of the most serious drawbacks to the development of tidewater North Carolina during all its history. We have studied malaria. Men of science have given their lives to it, and one fact has been thoroughly demonstrated, and that is that the mosquito carries the infection of malaria, or the malarial germ. When it bites a person suffering from malaria it takes up the germ and then if he bites a well person, unless such person is strong enough to eliminate the germ, that man will become a victim of malaria. We know the only effective way to eliminate the mosquito is through drainage. If our farms and a reasonable space from our homes are free from stagnant water of any kind, and if we have in addition screened houses, we can avoid malaria just as successfully as the person living upon the highest elevation in the mountains of our state; and if there is one movement which is more successful today than any other it is this world-wide movement for the conservation of the public health. No matter how Mr. Rockefeller gives his wealth and I am no sponsor for him in any respect and have never seen him, yet I thank him for that donation for the eradication of the hookworm from the south. That hookworm commission not only in its attempt to eradicate that disease, but in the eradication of many other diseases affecting our people, has made it possible, through the liberality of our own Legislature in the establishment of a State Department of Hygiene, a continuation of this great work in the promotion of the public health, and has greatly lessened the mortality in our state.

Looking back, as a boy, I recall the time when I saw men in our town who were pointed out as being absolutely worthless. They were indolent and absolutely counted for nothing as a factor in life. They were criticized, they were

blamed, they were ridiculed. I realize now that these men were the victims of hookworm or of malaria, or both, and with this thought about health, which I express about other movements, I am going to close. That great question which thrilled humanity at the beginning of our race, "Am I my brother's keeper?" applies to this question of the conservation of our public health. If we, by neglect and indifference and failure to engage in the common service for the benefit of humanity, fail to participate in these movements which make for the conservation of the common health and thereby our neighbors become diseased, we who are intelligent and are blessed and know our duty and have failed to discharge that duty, have in our own consciousness or at the bar of judgment no claim to absolution. There lies at the very root of all these upward movements which make for the benefit of humanity a spirit of service and a disposition to coöperate.

The President of the Association made the following suggestion:

While, perhaps, there is no particular amendment up for discussion, yet any suggestion from any of the delegates regarding what they consider necessary to make the North Carolina drainage law more effective and more operative are now in order.

I would make this suggestion, myself, that any of you who have or feel that you know of some changes that should be made in the North Carolina drainage law and you do not feel like trying to give them here, if you will write them out and then send them in to the chairman of the Legislative Committee they can be considered carefully by that committee. I might say that the Legislative Committee acting now is the one that the President appointed at the Charlotte meeting and that held over through this meeting; and that another committee, or the same committee enlarged, will be either appointed or continued for the coming year. The Legislative Committee this year has hard work before it, because of the meeting of the General Assembly in January, and we want our Legislative Committee, which does represent and express the opinion of the Association, to have drawn up and ready for introduction into the General Assembly of 1915 a bill that will express the amendments that we believe are necessary to make our North Carolina drainage law more effective and more operative. That committee will be asked by this Association to draft such a bill, and not only draft it and have it introduced, but go to Raleigh and explain to the committee—either the Drainage Committee or the Committee of the House as a whole—why they believe these amendments to the North Carolina drainage law should be passed. I believe we will find that the General Assembly of 1915 will consider the suggestions of our Legislative Committee as the highest authority on drainage matters in North Carolina, and will adopt such suggestions as are made by that committee. You know as well as I do that it is not sufficient simply to have a bill introduced into a General Assembly. You have got to get back of that bill—you have got to have somebody in the House and Senate, especially in our drainage matters, to get back of that bill and then we as an association have got to get back of our Drainage Committee with the members of the House and Senate, and assist the committee in every way to explain why such legislation should be passed.

I think sometimes in trying to have a bill go through the General Assembly it is like trying to keep business up in merchandising or manufacturing.

There was a time when a merchant or a manufacturer could sit in his office and by simply sending out notices that he had such and such a thing for sale he could sell them, but now he has got to go after trade, and so it is that we get legislation through. You have got to have someone familiar with the legislation desired, some one who can explain and recommend it to the Senate or to the House, and that is what this Association will ask of its Legislative Committee. I was very glad Mr. Small brought out that question or point, that he hopes this Association will appoint a Legislative Committee that will be willing to serve and give the time necessary to secure the legislation desired.

I want to say again that before any bill is introduced it ought to be gone over so carefully and minutely in every detail of language that there will be no question as to its legality, no question about phraseology, and the men who introduce such a bill in the Senate and House can stand by and say emphatically: "We want it passed without any changes or amendments at all." I believe our Legislative Committee will, as they have done before, put such a bill into shape, and the men in the Legislature interested in drainage will get back of that bill and see that it is passed as recommended by the North Carolina Drainage Association. Such a committee will be appointed by the President of the Association and be requested not only to draft or draw the bill, but to go to Raleigh, appear before the Legislature, and explain the reasons why it should be passed.

Mr. Peirce made the following suggestion:

As we stand now we are an independent organization, a private organization. We are without the assistance or help of the state except through the assistance we get from Dr. Pratt, as State Geologist. Of course, as President of the Drainage Association, and as President of the State Geological Survey, he has given us a great deal of assistance, but we are without the cooperation of the state. Now the law says that when we make this preliminary survey it shall be approved by the clerk, by the State Geological Survey, and then the Commissioner of Agriculture shall pay this money out from the treasury, but where they have made these payments and the districts organized and bonds sold they have not gone back to these districts and asked that the money be refunded to the state, so they could help organize and promote another district, but they come back and say, "We have no money available for that purpose." A. and M. College, and other sources, have taken this money. Now it seems to me we ought to have in the state a Drainage Commission. We have an Insurance Commission, a Commission of Agriculture, a Corporation Commission, and I say we must go to the Agricultural Commission and ask them to assist us in this way, and we are thrown off. It seems to me that in time we ought to have a Drainage Commission and let that be part of the organization of the State. The Supreme Court has held that these drainage organizations were private organizations. It seems to me we should arrange some way so that we could have these engineers under a Drainage Commission to do this work. Or the law ought to be amended to the effect that Major Graham or the Treasurer shall have that money in such shape they can supply it to districts when needed and some means of forcing the districts to return it at the proper time.

Another point is—I think we ought to get behind our legislators after these laws have been amended by this Committee and go up there in person if need be and see that they are enacted. Of course I am not a landowner, but I am interested in this drainage from a personal viewpoint. I would like to help the district and I feel that other attorneys would, too; and while we do not get much money out of it we hope to in the end. If I can be of any benefit in that way—going up there before the Legislature—I shall be glad to cooperate with you.

Another man: I would like to say further that I have had a conversation with the Commissioner of Agriculture along the same line. The Act of 1911 provided that with certain papers approved by certain parties, that any sum of money up to \$2,000 in one district shall be paid out of the funds in the State Treasury to the credit of the Agricultural Department. As a matter of fact the State Treasurer never seems to have this to the credit of the Agricultural Department unless the Commissioner of Agriculture sets that sum aside for this specific purpose. The law is one thing and the state keeps books another. The State Treasurer is merely treasurer *ex officio* for the Department of Agriculture, and unless there was some way to force the Commissioner of Agriculture to deposit that \$15,000 as set aside in the law * * * to provide these funds when called for, that law is ineffective. I think there have been \$11,000 advanced by the Department of Agriculture, out of which \$7,000 has been paid back. The other \$4,000 is still in litigation; so the Department of Agriculture, to comply with the law of 1911, still lacks \$11,000 in the State Treasury to further this drainage movement.

Dr. Pratt: At the beginning, as just brought out, there was no money in the general treasury to the credit of the Agricultural Department that could be used for this purpose; but, after the question was taken up with the Commissioner of Agriculture, arrangements were made by which approximately \$10,000 was set aside by the Commissioner for that purpose, and the understanding was that that money was to be used over and over again; but there was a difficulty experienced after that money had been loaned to the district. I have no authority at all as State Geologist regarding this money—and I went before the Commissioner of Agriculture and he said he had no authority to have it paid back. The Treasurer said he had no authority to try to recover or have paid back that money to the general treasury. The Attorney General said he had no authority. So it has been four years since the law was passed and there was no one who considered it his business and authority to demand that the money be paid back. There was approximately \$7,000 of that which was loaned that has been paid back. I think the total loan approximated between \$11,000 and \$12,000, out of which \$7,000 have been paid back; and according to the spirit and letter of the law should again become available to use to advantage in other districts. Now I have signed, I have forgotten what the total is, but I have to sign and approve the payments made out of that fund * * *. The last signed have not been paid. I do not know whether that \$7,000 went back to the general Agricultural fund to be again drawn upon by the Department of Agriculture for specific purposes and that the commissioners will have to again designate that a certain amount was at the disposal of the State Treasurer, to be drawn upon for this particular purpose. That is a point I think well brought out, and we will have it considered by the Legislative Committee, to see if they can in some

way have that particular clause in that second section modified or amended so it will definitely stipulate who is to see that the money is put back into the general treasury, and when it is to go back, so as to become at the disposal of the State Treasurer to be used again. That was the idea in the beginning, that \$15,000, if made available, would be sufficient to keep up the preliminary surveys and engineers' charges in connection with the drainage districts as they were organized. After the law was passed they passed a law that the State Geologist would pay expenses of drainage districts to the amount of the \$15,000, taking the entire appropriation of the State Geological Survey for that work. You can imagine that the State Geologist did not consider he had authority to pay. In the same year that that was designated, the Legislature also imposed upon the State Geologist other debts that required approximately from \$25,000 to \$50,000, making a total of \$60,000 or \$70,000 to be paid by the State Geologist out of a \$15,000 appropriation. Some of the work had to be left out. I would like to second the suggestion made that this be referred to the Legislative Committee, and they take under consideration that particular section to see if it cannot be modified and the money cannot constantly be put in the State Treasury, and the same \$15,000 be used over and over again.

Mr. Thompson: I would like to speak along this line. It seems to me that the greatest need now before the districts is to give additional security to the money they try to borrow. Three-fourths of the districts in the state are small districts. They are worth \$25,000 or less. It is difficult to go outside the state and get that much money to drain the districts. A number are unable to proceed because they cannot get money locally. Districts are being formed rapidly in the state and with the splendid forms that Dr. Pratt has gotten up for us the organization is very much simplified. That brings us up to the point of going ahead and doing the work. The lands are good for it and we get six per cent investment. There are a good many folks in the districts dissatisfied with the progress made in selling the bonds and risks are taken in making sales. There is not much money idle in North Carolina. Unless the local banks are interested it is very hard to get it, and I think we ought to provide some legislation to give such security as will make them attractive to bond buyers. If we can get the county commissioners to either approve or endorse the drainage bonds, I believe it would make them more salable. If they had that spirit of coöperation Mr. Small was telling us about, they ought to help the drainage district in their own county, and they would be more vitally interested. I think some legislation along that line is especially needed for the smaller districts. We have seventy-two districts, I believe, and I do not think there have been probably more than eight or ten of these bonds sold outside of the State; so we have to look to the banks of the state to get the money to do this drainage work.

Colonel J. B. Sellars: In regard to the first payment of bonds, it seems to me we ought to have at least one year intervening between the time for these payments. That is one weakness in our law. I never saw a bond issue in my life collected all at one time. I offer that as a kind of suggestion. Dr. Pratt, I do not know just the condition in regard to the bonds of the Back and Jacob Swamp Drainage District, but in 1911 that point was brought up and the drainage law was amended with that particular point in view, that the first collection shall be made in the fall of the year before the year of the

first assessment or first payment was to be made, so that there would be no question whatever about the interest and assessment being ready when the first payment became due. As in this 1915 payment, assessment was not really to be paid until the 1916 assessment and interest came due. That was the question raised in connection with the amendment in 1911.

Mr. Brett: I think under the present law care is taken of this first payment, and the tax rolls so made out that the tax becomes due when the first payment is due. For instance, a bond issue due March, 1917, the tax is collectible the September before. In other words, instead of having it become due in September, and your bonds payable in October of the same year, just push your tax roll forward one year, as far as its due date is concerned. I would also like to take up the point made by Mr. Thompson. I think we have ample security as far as the drainage bonds are concerned. I have marketed a number of drainage bonds, and even now right in North Carolina among leading bankers a North Carolina drainage bond is considered one of the best securities we have to offer. The only reason it does not find a ready market is that our laws are antiquated and tie up their hands so that they cannot invest except in certain securities.

I do not think it is necessary to amend our drainage law by putting other paper behind it. We have the land behind it. Since we have had the amendments put in our law that compels the sale of land on certain specified dates, we have had very much less trouble in selling it. There is one point which Mr. Thompson brings up and that is little bond issues. It costs the buyer just as much to investigate the small bond issue as the large ones. Consequently, when you are selling a \$15,000 bond issue and the bank wants to handle it at a profit, they have to buy a great many at one time, or else the expense of one issue is prohibitive.

Mr. Small: I would like to supplement what Mr. Thompson and Mr. Brett have said. I agree with Mr. Brett that there is scarcely a better security than that behind these bonds, subject to one condition. You cannot sell bonds unless they pass the scrutiny of a trained lawyer. None of these trust companies or banks will buy them unless they have been examined and approved by some lawyer who makes a specialty of that class of work and of acknowledged reputation, and they will not approve them unless the law has been scrupulously complied with in every detail. If there has been some omission perhaps in the posting of notices or advertisement or some other slight detail neglected and under the decisions of our court that would be regarded as necessary * * * and under some conditions would not be considered essential, yet you might point out this to one of these specialists and they would tell you that they must see the district formed in compliance strictly with the law. It does not mean the lawyer with the biggest reputation in the county, because lawyers with the biggest reputation are frequently not careful with the work they do. They are not good office lawyers. They are inclined to overlook little matters. But a lawyer who knows the law and will take the pains to see that every condition is complied with is the kind of a lawyer you want in the organization of a district, so that when your bonds are put on the market there will be no question as to their legality; otherwise, you will have trouble and a great deal of work to do the matter over again.

Mr. Thompson: Supplementing Mr. Small's remark would say that there is one specialist in the United States who makes a specialty of drainage bonds and many companies will not take the bonds until he has passed upon them, and he has suggested a number of changes in our drainage law.

Mr Brett: Take into account that a hard and fast rule for the election of drainage commissioners would hardly apply in that the same conditions do not exist in each district. Each district is an organization of owners of land to bring about specific things. In one district the leading tenant may own five acres out of fifty thousand. In another, the leading tenant may own forty thousand acres out of fifty thousand. So far it has been the custom for the clerk of the court to establish rules for the election of drainage commissioners governing each particular district, not trying to set any form of rules to cover the whole state. One difficulty appears to be in providing no way for drainage commissioners to be elected and possibly we might outline, in a way, how he can be elected, so there would be something like uniform procedure in all cases.

Mr. Pratt: I believe that it would not be necessary for a man to come and vote personally, but by proxy. I understand that in some districts they refuse to let them vote by proxy.

Mr. Johnson: A resolution that was prepared last night and that will be submitted to this Legislative Committee will, I think, meet that point somewhat—especially his allusion to the termination of office. I am very much interested in that part of the program myself, and in this resolution it provides that after the district has been completed and the assessment rolls all filed with the clerk or sheriff that the term of office of the commissioner shall expire within one year and thereafter an election shall be held each year to either reelect those commissioners or their successors, and I believe that will be helpful. A man who is not sufficiently interested in the administration of a district in which he owns property to come and vote is not worthy of very much consideration.

Now I want to tell you a story. I live in a very small town; we have a postoffice, a grocery store, etc. In my township we have three drainage districts, embracing about 80,000 acres of land, or about one-third of the area of drained land in the state, which has been completed, as I understand, and this law has been instrumental in causing the investment of hundreds of thousands of dollars in the development, clearing and cultivation of thousands of acres of land, and all of this swamp land is estimated to have been increased in value at least 75 per cent. While this organization, I think, is something like eight years old now, and while we have done more than any other part of the state in one particular section to follow this law, we have never yet had this Convention assemble with us, and I think it is peculiarly fitting that this Association should meet in our community next year. I want to read a letter that I have from the secretary of the Board of Trade at Belhaven.

BELHAVEN, N. C., November 17, 1914.

To the President and Delegates of the North Carolina Drainage Association at Wilson, North Carolina:

GENTLEMEN: At a meeting of the business men and citizens of Belhaven, held on Monday night, the 17th inst., a resolution was

passed sending a very cordial greeting to the North Carolina Drainage Association; and a pressing invitation to hold its next annual convention in Belhaven, North Carolina.

The Belhaven Board of Trade heartily joins in the resolution. We wish for your Convention a success and a realization of your desires.

Yours truly,

BELHAVEN BOARD OF TRADE,

Per Frank Snyder, *Secretary*.

We want you to come. We want you to visit this City by the Sea, where you get the sea breezes, and we promise you that you will find the doors all open. We want to take you there in a flat-land country, where the sky is bluer and the soil richer than you ever saw, and we think when you stay there a while you will agree with us that we have God's country in North Carolina, and that the further east you go, the nearer you approach your Creator.

Mr. Small: I would like to supplement what Mr. Johnson so attractively suggested about Belhaven as the next place of meeting, and to add a suggestion. We usually have our meetings in November. They have as fine oysters there as can be had anywhere—it is near the oyster ground—they are right at the door-way, and the finest fish anywhere. I do not know of a more delightful view anywhere than in front of Belhaven. You will have an opportunity of being taken through these drainage districts and you will be delighted to see good roads, great canals, nice farm houses, and improvements made on land which before being reclaimed was a perfect morass of weeds, undergrowth, large timber, and frequently water from one to several feet deep, from mountain rainfall. And there is one other attraction: You have heard one of the gentlemen this morning describe the Mattamuskeet Lake District. That is the most unique diking district in the United States—in some respects the largest. You will never have an opportunity to hold this meeting at a place nearer that great drainage district than Belhaven. The people there, I know, will be delighted to take you in their motor boats to Swan Quarter, to Juniper Bay, near the great Dismal Swamp Drainage District, and there you will have an opportunity to see all this next November. So if you want to hold a drainage convention right in the midst of drainage improvements of the most unique and interesting kind, I hope you will accept the invitation that Mr. Johnson so graciously extended.

Adjourned to 2:30 o'clock.

AFTERNOON SESSION—Thursday, November 19

Mr. Lawrence Brett, Drainage Engineer, made an address on "Some New Factors in Drainage Work in North Carolina."

Mr. President, and Ladies and Gentlemen of the Convention:

It has always been my good fortune, or perhaps my ill fortune, at these conventions to speak right at the end of the program, when everything that I have prepared to say has been said by someone else in a much better way than I could say it myself. However, there are a few points left that perhaps have not been discussed, and I will have to treat them in a more or less extemporaneous manner. What I have prepared to say has been said and I know you will not want to hear it over again.

The work of the North Carolina Drainage Association was founded upon the sentiment of the progressive people of the state who realized the need of drainage. They found they had no way to coöperate and secure what they needed in the way of relief from swamp land conditions or overflowed conditions. This sentiment called for the organization of the North Carolina Drainage Association, which was organized in New Bern in 1908. The first meeting of the Association framed through its committees the North Carolina drainage law under which we are operating today, with some amendments.

In 1909-1910 this law was first put into effect, and in 1911 we found that certain amendments were necessary to make the law more applicable to the conditions under which we have to operate. These amendments were made, and since then the law has worked probably a good deal better than at first; however, we realize that our law is still far from perfect, and that we have a good many things to do to improve it. A good many points have been discussed at this convention in reference to amendments to the drainage law. These matters have been considered carefully by the Legislative Committee, and I think in time we will develop a law that will be as near perfect as any law can be.

Now, all these points have been at different times new factors in the drainage work of North Carolina. At the last meeting of this Association and next to the last meeting, which was held in Raleigh, we first began to discuss what we will do with our swamp and overflowed lands, once they have been reclaimed. The problem of settling the lands is one that has taken a good deal of the thought of those engaged in drainage work. The drainage engineers and landowners have been interested and all who have had to deal with drainage work in any capacity have been interested in what we will do with the lands. We have solved most of the problems in engineering; at least we know we can successfully drain the land; our agricultural people assure us that we can farm them at a large profit; but who is going to do the farming? This problem of settling the lands has been a very serious one.

At present there are six large development companies operating in North Carolina who propose to bring settlers to the swamp and overflowed lands. The entrance into the drainage field of these development companies, in my opinion, marks a distinct advance in drainage work, as it brings in a different viewpoint from that from which we have been observing the problem. This year I have had occasion to be connected with three different enterprises of the six in one capacity or another, and I find among those interested in these development companies no spirit of competition. What they all want is to bring people into North Carolina, and if one development company cannot sell them land, perhaps the other can, and each sale is an advertisement of the rest; consequently, with no exception, there has been the most hearty coöperation among the six companies selling land in North Carolina. Most of these are coöperating, not by actually getting together and discussing plans, but by aiding in every way possible all of the projects and all of the publicity that can be given to drainage work in North Carolina. Some of these companies started up by draining their lands first and bringing them into cultivation, and then offering them on the market.

One of the distinct advances of this nature has been the entrance of a large company from the west. They started in, not as an engineering organization, but as a sales organization. They had a well-organized sales force to sell land and they had the land to sell. The drainage problems were taken up next

and solved with a view actually of subdividing that land and selling it. The sales force kept pace with the work that was laid out and planned, and before any construction work was done they had already sold to settlers nearly twenty per cent of the first 25,000 acres they are now starting to drain. I look for much future activity in drainage work in North Carolina.

The terrible European war, which is now attracting the attention of the world, will, I believe, when it is over, mean a gradual increase in desirable immigration to the United States. Those of us who have swamp land to offer at a reasonable figure and in such shape that a man can come in and farm on it, will find no lack of desirable citizens to occupy it.

We have, as we have said, solved the problem of draining the swamp land. When we first commenced to discuss this question at our meetings there was a great deal of pessimism shown in the remarks that this and that could not be done. While we may have no opportunity to answer all those who offer objections to drainage propositions, every drainage district that has undertaken work has gone on with it and successfully completed it. We have actually drained every swamp and every area that has been undertaken, and now that this has been done the supposition that swamps cannot be drained is no longer heard. We know we can drain the land to give it the outlet or main drainage, and lateral and tile drainage are bound to follow.

I look to see as a new factor in the work of this organization, and one we should try to emphasize in the future, the drainage of the farm. We are just as interested in draining the small farm as we are in draining the large areas. It takes legal machinery to handle a large proposition. In some districts we have as many as seven hundred, eight hundred, or a thousand farmers to bring together and get their coöperation in order to bring about the successful completion of some large, comprehensive drainage plan; but this large drainage plan leads only to the small drainage plan. After we have provided the outlets and ways to take off the water the next thing is to get the water into these canals or means of being carried away. We talked yesterday of tiled drainage and the demonstration we had was very good and was very much appreciated by this organization.

This organization has seen practically all classes of drainage work in operation—in the Dismal Swamp of Virginia, in the Piedmont section of North Carolina, and we know that this character of work can be done. We hope next year to view some other class of drainage work.

Now the most important new factor of those I have enumerated is the settlement of our lands. This, I believe, is beginning to be solved. When the swamp lands of North Carolina were first put on the market, it took years of most painstaking effort to make any sales whatever. Now, where you formerly found the sections knee-deep in water, you find thousands of acres of corn growing in one field. Farmers from the middle west are settling on the lands and making them productive. This Association will in the future have to coöperate in letting the virtues of North Carolina lowlands be heralded abroad, so that those outside of the State may know what we have to offer.

A few weeks ago I had the pleasure of addressing a small group of land-buyers from Illinois, who were coming down to look at swamp lands in North Carolina which were being offered for sale. These men—most of them—were ready to buy; they had the cash to pay for the farms, although long term payment was offered. But they knew what they wanted, what characteristics of the soil were required for the successful raising of corn, and what were

required for the raising of other crops. They were not interested in raising truck, cotton, or tobacco, but in raising the crops with which they were thoroughly familiar, and they wanted to know when they went on a piece of land what it had to offer them in the way of return for the work and money they would expend on it.

This desire for knowledge on the part of land-buyers has caused this particular development company to have an experiment farm installed under the charge of an expert, so that if a man wished information in regard to a certain soil he could take samples of that soil, have it analyzed, and find in what particular characteristics that soil was lacking, and what treatment that soil would need to be most productive for the particular crop he wished to raise. This service was furnished free by the development company through the best experts they could get for the prospective purchaser. This is just one phase of work they are doing.

We all want to know how we are going to dispose of our lands when they are drained in large lots. In the drainage districts similar to those between the Piedmont and the low flat areas in the eastern section of the state the matter of selling is not a problem. Most are long, narrow areas, where the ownership of the land is held by a great many people, some owning from ten to five hundred acres, but where the drainage work is being done by each individual farmer for his own good and not by a development company. This applies to sixty to seventy per cent of the drainage districts of North Carolina, but in area the percentage is not so high. The expense of draining these long, narrow districts is greater, but as soon as the land is drained the farmer has added directly to his holdings that much land. He knows how good it is, and can profit by what these larger companies that are making a specialty of it have found out in regard to the treatment of swamp land.

We hope by the next Convention to have data and information for the use of the Convention and its delegates as to the treatment of the swamp lands and as to what crops they are best adapted to.

I think we are just beginning the great forward movement in drainage in North Carolina. As soon as the present difficulties are overcome there will be more drainage work done in North Carolina than we have done in the past six years. Almost everyone interested in drainage work now has in contemplation more work than has ever heretofore been done. The interest manifested in this is growing. While our attendance is not as large as we would like, those who are present came solely for work. We come here to discuss points of difficulty with which we have met, and I hope that this Association may continue to be able to solve in a measure the problems arising as they are presented.

Let us keep our organization strong; let us be eager to show the benefits that will accrue to the state through our efforts; let us continue to make the North Carolina Drainage Association a leading and ever new factor in the progress and development of our state.

DISCUSSION.

Mr. Mengel: I want to emphasize one point in regard to the Drainage Association in the future in relation to these new development companies. I approve the idea of giving people exact knowledge of what they are coming into before they come down. I think the Association, as an Association,

should offer support in the way of publishing and distributing literature and recommend to anybody desiring land that North Carolina is the place to come.

Mr. Brown: I want to say one word in commendation of the plan referred to. I know something about that myself. In bringing to North Carolina farmers from the north and west—here is a caution. Do not bring Europeans unless they come from north of the English Channel or Baltic Sea.

Mr. Brett: The development companies in North Carolina are new factors in drainage work. The individual landowner that coöperates to form a drainage district is the North Carolinian who is interested in developing his own holdings, but if it is good for him the investor or promoter will say—why would it not be a good thing for me to buy five or ten thousand acres, develop it and sell it. I look askance at some of these propositions because there have been colossal frauds put on the American people in selling what are supposed to be drained lands. When I first became associated with some of these land companies I was a little bit critical of their methods until I found out they went on the basis that unless it was first-class we do not want to be associated with it, because unless the purchaser can buy our land and make a living on it, we won't make any progress. That one thing has actuated the methods of every development company in North Carolina. They sell on easy terms—the farmer can come in for small cash payments, and they assist him in every way to make a success of the undertaking. They deserve our highest praise and warmest coöperation.

Reports of Committees

COMMITTEE ON RESOLUTIONS.

The North Carolina Drainage Association in this its Seventh Annual Convention may well be pleased with the progress of the work done and the good results therefrom throughout the middle and eastern sections of the state. These results are inspiring greater activity as they become better known and the work of reclaiming our swamp lands has already reached a stage of certainty as to the profitableness in other respects than for agricultural purposes.

The drainage and incident reclamation and development of our swamp lands brings many phases of betterment to the community and to the state, by way of producing more and better assets in the form of products raised, which necessitates the movement for good roads by which to market such products. Good roads will lead to good schools, which will promote better citizenship, modern farming, increased values, and the substance of living at home.

Resolved, That we urge the General Assembly to carefully consider what we have already done for the advancement of this work by investigating the good that has been accomplished in the work of agricultural development and incidentally increased revenues and values of farm lands, after which we feel they can better see the needs for the coöperation of the whole state in this work.

Resolved, That this Association urge the committee and other officers of all drainage districts, which have been organized and completed, to attend

the annual Association meetings and make reports of their districts for the benefit of the Association, we believing that those having experienced the benefits are more capable of imparting this information and that we believe the same would be a great help towards the furtherance of the cause of drainage.

Resolved, That we urge the General Assembly to give careful attention to the necessity for legislation which will protect our drained swamp lands from fires and our canals from damage caused by stock running at large. We commend to the consideration of our representatives at Raleigh the fact that our drained swamp land and overflowed areas are of great value and that their protection is a matter of public welfare.

Resolved, That this Association coöperate in any state- or nation-wide movement to encourage immigration to this state. We realize that one of the most important factors in the success of the drainage work is the bringing in of a desirable class of settlers who will live on their lands and cultivate them. We should welcome and aid the newcomer, and he will make us a good citizen and aid us in realizing the possibility of ours.

Resolved, That we commend to the General Assembly the State Geological and Economic Survey as worthy of most generous support, representing as it does most important activities that are constructive forces in the upbuilding of our state.

Resolved, That we extend our thanks to the United States Department of Agriculture, to the office of Experiment Stations and to the Board of Drainage Investigations for the aid they have given in solving our drainage problems, and in placing in our state an able and efficient drainage engineer to advise our people and help us with our work.

Resolved, That we extend the thanks of this Association to the State Department of Agriculture and to its various officials for the work done by demonstration farms and soil surveys and in placing an engineer in the field to aid in drainage work.

Resolved, That this Association extend to the officials of our railroads thanks for their interest in our work, and particularly to the Norfolk Southern for the address of Mr. B. E. Rice, and his participation in the Convention.

Resolved, That the Association extend to Congressman John H. Small thanks for his untiring interest in our work and for the inspiring address delivered before this Convention.

Resolved, That the Association express its appreciation to the John L. Roper Lumber Company for their interest in our meetings, and for the instructive paper presented by their representative, Mr. C. W. Mengel.

Resolved, That we extend thanks to the press of the City of Wilson and to other papers in the state for giving publicity to this Convention and its work.

Resolved, That we extend thanks to Mr. J. C. Cowley for his interesting and helpful demonstration of tile drainage on his farm, and to urge him to attend all of our annual meetings in the interest of tile drainage.

Resolved, That this Association extend thanks to the City of Wilson and its officials for the hearty welcome and support of the Convention; to the Commonwealth Club and the Chamber of Commerce, and to the Entertainment Committee and citizens of Wilson and the County, for their careful at-

tention and many courtesies extended all our delegates; to the City for the use of the City Hall, and to the management of the Opera House for its use as meeting places for the Convention.

W. K. ALLEN, *Chairman*.

JOHN H. SMALL.

J. G. MILLS.

H. M. LYNDE.

P. H. JOHNSON.

M. E. SHERWIN.

J. C. STANTON.

C. A. FARNELL.

The report of the committee was accepted and the resolutions were unanimously adopted by the Convention, as introduced.

The Membership Committee made its report as follows:

REPORT OF MEMBERSHIP COMMITTEE.

With the future of the large reclamations assured, it is important that more farmers become active members of the Association. To that end your committee recommends that this Association invite the attention of the officials of the Farmers' Union, the Forces of Farm Demonstration Work, the State Department of Agriculture, and especially those engaged in institute work, because if the individual farmer is not interested he will not apply improved methods of farm drainage and thereby reap the benefits to which he is entitled from the organized districts in his own communities.

We feel that as good drainage is indispensable to good road construction and maintenance, that this Association invite every highway engineer in the state to become identified with the interests and activities of this Association.

There are fifty-nine delegates registered, representing sixteen counties in the state, and two delegates from Virginia.

M. E. CHAPPEL, *Chairman*.

E. E. SCHOOLEY.

ZENO MOORE.

H. D. BROWN.

The report of the committee was accepted and adopted as read.

Counties Represented at Convention

The following counties were represented at the Convention: Beaufort, Edgecombe, Gaston, Greene, Guilford, Hyde, Lenoir, Nash, New Hanover, Orange, Pender, Robeson, Wake, Washington, Wayne, and Wilson.

Mr. Brett, chairman of the Legislative Committee, made the following report:

REPORT OF LEGISLATIVE COMMITTEE.

The undersigned, your Legislative Committee, beg to offer the following as their report:

Since the Charlotte meeting of the Drainage Association your committee has discussed at various times the matter of amendments to the law and has

by correspondence gone into this matter with several members of the Association. We have in our possession a considerable amount of material which we have collected relative to proposed amendments. Realizing that in order to make our work effective we must take time and give careful consideration to the amendments proposed and to the relation of the general law as it now stands, we recommend to the Association that a Legislative Committee be appointed by the Association to which we will give the data collected by us and with which we shall be pleased to cooperate in every way. We recommend that each committee, when appointed, set aside the necessary time and meet at some central point, there to go over thoroughly all proposed changes to the drainage law, and to put the same in shape to be introduced at the next meeting of the General Assembly of North Carolina.

We respectfully recommend to the Association the necessity for the committee so appointed to give of its time a sufficient amount to see that the amendments proposed have careful consideration by the General Assembly and to have a sufficient number of its membership present in Raleigh to explain and defend the amendments desired and to see that, if possible, the recommendations of the Association are carried out without change.

We urge on every member of the North Carolina Drainage Association that amendments desired be considered and that members interested in changes of the law put their desires in writing and address the same to the Chairman of the Legislative Committee. In this written form the committee will have all facts before it.

Respectfully submitted,

LAWRENCE BRETT, *Chairman.*

JOHN H. SMALL.

JOHN P. KERR.

M. F. H. GOUVERNEUR.

E. B. CROWELL.

G. B. SELLARS.

M. W. THOMPSON.

J. L. BECTON.

DISCUSSION

Mr. Brett: We have fifteen pages of typewritten matter submitted in regard to proposed changes. We cannot say we will recommend this or that until we have all in hand that we want to consider, because we do not want to make any mistake and recommend something that will put our law in such a shape that it won't work; but we want everybody who has amendments to be taken up at this meeting to put them in written form and report to the committee appointed today and we will hand over to the committee the data we have, so that when this committee meets prior to the Legislature and re-drafts the drainage law, they will have all the information in hand with which to work. We cannot say we recommend this today, until we know if something better is suggested, because we want to serve all parties in connection with this amendment.

The report of the Legislative Committee was adopted as read.

The report of the Committee on Nominations and Next Meeting Place was read by Mr. C. W. Mengel, in the absence of the Chairman of the Committee, Mr. J. A. Wilkinson.

REPORT OF THE COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

We, the Committee on Nomination of Officers and Next Meeting Place, beg leave to submit our report, as follows:

Place for next meeting—Belhaven.

For President—Mr. Lawrence Brett, Wilson.

For Secretary-Treasurer—Dr. Joseph Hyde Pratt, Chapel Hill.

For First Vice-President—Mr. P. H. Johnson, Pantego.

For Second Vice-Presidents the following:

Anson County—E. A. Barrett, Polkton.

Beaufort County—P. H. Johnson, Pantego.

Bertie County—Francis D. Winston, Windsor.

Bladen County—O. L. Clark, Clarkton.

Brunswick County—Jackson Johnson, Town Creek.

Cabarrus County—J. Lee Crowell, Concord.

Chowan County—W. S. Privott, Edenton.

Columbus County—Joseph A. Brown, Chadbourn.

Cumberland County—W. A. Beard, Fayetteville.

Cleveland County—G. F. Hambright, Kings Mountain.

Gates County—A. T. Godwin, Gatesville.

Guilford County—M. W. Thompson, Greensboro.

Halifax County—John L. Patterson, Roanoke Rapids.

Harnett County—A. J. Dunn.

Hertford County—R. C. Bridger, Winton.

Hyde County—Greeley Brinn.

Iredell County—E. S. Milsaps, Statesville.

Jones County—J. H. Bell, Polloksville.

Lincoln County—W. A. Graham, Lincolnton.

Mecklenburg County—W. S. Pharr, Charlotte.

New Hanover County—B. F. Keith, Wilmington.

Onslow County—E. M. Koonce, Jacksonville.

Pender County—J. A. Ziblin.

Pitt County—Alston Grimes, Grimesland.

Robeson County—J. B. Sellers, Maxton.

Rockingham County—R. P. Richardson, Reidsville.

Rowan County—C. M. Miller, Salisbury.

Wake County—J. G. Mills, Wake Forest.

Wayne County—W. W. Peirce, Goldsboro.

Washington County—Van B. Martin, Plymouth.

We also ask that the President appoint second vice-presidents in counties not represented on the list, as he may see fit.

Respectfully submitted,

J. A. WILKINSON, *Chairman.*

C. W. MENGEL.

F. R. BAKER.

W. W. PEIRCE.

R. M. SQUIRES.

D. B. MCNEILL.

T. W. CHAMBLISS.

The report was accepted and upon motion the Secretary was instructed to cast a ballot for the officials as recommended by the committee. These were declared unanimously elected.

Belhaven was unanimously voted the next meeting place.

The new president was escorted to the chair by Mr. W. K. Allen and Mr. P. H. Johnson, and addressed the Convention in the following words:

It is needless to say that I consider this a great honor. I have been interested in the work of this Association from the beginning. I have watched its growth with a great deal of interest and have done, so far as I was able, everything possible to further drainage work in North Carolina. As the new President of this Association I shall try to do even more than I have tried to do in the past, and to work and to give my time to the interests of this Association wherever possible.

I appreciate very much the honor you have given me, coming as it did very unexpectedly, but I will do the best I can to further the work of this organization.

Dr. Pratt called attention to the model prepared by Mr. F. R. Baker, illustrating tile drainage and charts illustrating different phases of tile drainage which were exhibited in the Opera House. He also called attention to the points of interest in Wilson, listed on the last page of the program, and to "Peg O' My Heart," which would be played in the local opera house the evening of November the nineteenth.

DISCUSSION.

Mr. Small: I would like to present to the Association this thought, in the form of a query: Why can't we have four hundred or five hundred delegates in attendance at the next meeting of the Association? We ought to have them. I am sure that every delegate who has attended this session, as during every past session, would say that he has been benefited by it. I am sure that they have been benefited and have become more or less enthusiastic over the improvements that this drainage problem has been emphasizing. If that is true we can do a public benefit by extending that individual benefit to a number of others. If I may make a suggestion I would suggest that beginning two months before the next meeting of the Association that the President of the Association adopt this plan: By looking over the printed proceedings of the past meetings he could get the name and address of every delegate who has attended at any time, and a letter to each of them, together with a few others in various counties whose names might be suggested, asking them to suggest the name of every citizen in their county who might be induced to attend the meeting. Then, having obtained a complete list of perhaps one thousand or fifteen hundred names, to prepare a signed letter to be sent to each one of those names, setting forth as briefly and attractively as possible, in not more than one page, the purposes of this Association, its claims to public support and confidence, and asking the question as pointedly as can be done without offense—whether he can attend. Enclose a stamped envelope and ask him to write whether or not he can attend, and he will feel under some compunction to reply. I know it involves a good deal of trouble,

but if it will bring to our next meeting four hundred live and purposeful delegates it will be like the traveling man from Baltimore who made a trip to North Carolina and had to pay three dollars for a quart of whiskey. But he said it was worth the cost; so this effort will be worth all it costs. I suggest that the President do this because the Secretary is pretty well worked, not only with this Association but with the North Carolina Highway Association and several other activities of the state, and also because he has been so closely identified with this Association that a new name might be a little more compelling, and I believe instead of the delegates to the next meeting being confined to the area near the place of meeting, that we can have them scattered through the state more largely and, in addition, increase our attendance certainly one hundred, if not two hundred. We are all subject to be influenced by our environment, and it won't do to let this attendance get too small, for if we do some will say—nobody else is taking interest, why should I? If we can get three hundred or four hundred at the next meeting we will have a new start, and while my friend, Mr. Johnson, can talk for himself, I want to say that Belhaven is a good place to go to. It is a nice town—has a fine public school building and fine public schools, a live Board of Trade and Secretary, and is the most delightful place on the water in North Carolina. The point I want to make is to have four hundred delegates next time and resolve to help the President. The President does not mind work, and I have always found that the more work a man does the more he can do and does. After an experience of fifty years I am prepared to say that the only men who really perform their promises and do all the work allotted to them systematically and on time are the men who have plenty to do all the time.

Mr. Johnson: I would like to suggest just one query that should appear in that letter to be sent to the delegates: "Have you ever been to Belhaven? If not, why not?" And I want to say to you that we will promise every one who attends that Convention that we will show you actual development, not only of canals that have been cut, but we will show you land being cleared in all stages, beginning where the first trees are being cut down and ending in a bumper corn crop. In addition to that we will take you down and show you the Mattamuskeet Lake project and we will show you that we have ample accommodation to take care of the four hundred delegates, and more if they come, and we shall be greatly disappointed if we have less than four hundred present.

To the President I want to say that the Board of Trade will be glad to coöperate with him in any scheme he may devise to help get that crowd there.

**Registered Delegates to the Annual Convention of the North Carolina
Drainage Association, Held at Wilson, November 18-19, 1914**

Allen, W. K.....	Wilmington, N. C.
Baker, F. R.....	Raleigh, N. C.
Barnes, K. W.....	Lucama, N. C.
Becton, J. L.....	Wilmington, N. C.
Berry, Miss H. M.....	Chapel Hill, N. C.
Boddie, Nick B.....	Nashville, N. C.
Brett, Lawrence	Wilson, N. C.
Brown, F. A.....	Wilson, N. C.
Brown, H. D.....	Wilson, N. C.
Cardwell, Guy A.....	Washington, N. C.
Chambliss, T. W.....	Wilson, N. C.
Chappel, M. E.....	Swan Quarter, N. C.
Clarke, J. L.....	Richmond, Va.
Cooper, C. W.....	Wilson, N. C.
Cowley, H.....	Creamsdale, Wilson, N. C.
Cowley, J. C.....	Wilson, N. C.
Cox, J. W.....	Elm City, N. C.
Crittenden, H. T.....	Box 444, Wilson, N. C.
Davis, W. J.....	Wilson, N. C.
Deans, A. B.....	Wilson, N. C.
Freeman, R. W.....	Wilson, N. C.
Frizzelle, J. T.....	Greene County.
Gass, A. S.....	Wilson, N. C.
Gay, S. S.....	Nashville, N. C.
Gold, P. D.....	Wilson, N. C.
Graves, M. W.....	Wilson, N. C.
Hodges, C. W.....	Kinston, N. C.
Johnson, P. H.....	Pantego, N. C.
Keith, B. F.....	Keith, N. C.
Land, Charles A.....	Borden Brick and Tile Co., Goldsboro, N. C.
Lane, H. B.....	Wilson, N. C.
Lucas, Silas	Wilson, N. C.
Lynde, H. M.....	Raleigh, N. C.
McArn, Miss Nan	Chapel Hill, N. C.
McNeill, D. B.....	Lumberton, N. C.
Mengel, C. W.....	Winona, N. C.
Mewborn, L. J. H.....	Snow Hill, N. C.
Milk, J. G.....	Wake Forest, N. C.
Moore, Zeno	Whitaker, N. C.
Ormond, W. W.....	Greene County.
Pace, T. S.....	Wilson, N. C.
Patrick, D. W.....	Greene County.
Peirce, W. W.....	Goldsboro, N. C.
Poe, S. E.....	Mt. Gilead, N. C.
Pratt, Joseph Hyde	Chapel Hill, N. C.
Rice, B. E.....	Norfolk Southern Railroad, Norfolk, Va.
Roney, J. G.....	Wilson, N. C.

Schooley, E. E.....	Belhaven, N. C.
Sherwin, M. E.....	West Raleigh, N. C.
Small, John H.....	Washington, N. C.
Squires, R. M.....	Wake Forest, N. C.
Stanton, J. C.....	Stantonsburg, N. C.
Strickland, N. L.....	Nashville, N. C.
Thompson, H. E.....	Stantonsburg, N. C.
Thompson, M. W.....	Greensboro, N. C.
Wickham, W. J.....	Route No. 4, Wilson, N. C.
Wilkinson, J. A.....	Belhaven, N. C.
Woodard, Walter F.....	Wilson, N. C.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.* ffi
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*
23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*
24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 plates, 5 figs. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virginina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hydronite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of western North Carolina are described, giving distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virginina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Lola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; The new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, Forester, 1915. 8°, pp. *Postage cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage ½ cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey

for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 190 pp. *Postage 14 cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 42

ORGANIZATION
OF
CO-OPERATIVE FOREST-FIRE
PROTECTIVE AREAS
IN
NORTH CAROLINA

BEING THE

PROCEEDINGS OF THE SPECIAL CONFERENCE ON
FOREST FIRE PROTECTION

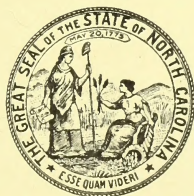
HELD AS PART OF THE

CONFERENCE ON FORESTRY AND NATURE STUDY

MONTREAT, N. C., JULY 8, 1915

PREPARED BY

J. S. HOLMES, State Forester



RALEIGH

E. M. UZZELL & Co., STATE PRINTERS AND BINDERS
1915

N 557
N 813e

GEOLOGICAL BOARD.

GOVERNOR LOCKE CRAIG, <i>ex officio</i> Chairman	Raleigh
FRANK R. HEWITT	Asheville
HUGH MACRAE	Wilmington
HENRY E. FRIES	Winston-Salem
JOHN SPRUNT HILL	Durham

JOSEPH HYDE PRATT, <i>State Geologist</i>	Chapel Hill
---	-------------

LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., September 1, 1915.

To His Excellency, HONORABLE LOCKE CRAIG,
Governor of North Carolina.

SIR:—On account of the importance of the protection of our forests from fire, I herewith submit for publication, as Economic Paper 42, a report on the Proceedings of a Special Conference that was held at Montreat, North Carolina, July 8, which took up the organization of coöperative forest-fire protective areas in North Carolina. As a result of this conference, several of these areas or districts have already been established.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.



PREFACE.

The enactment of the new forest fire law by the General Assembly of 1915 made possible coöperation between the Federal Government and the State Geological Board in forest fire protection. An agreement was thereupon entered into between the Secretary of Agriculture and the State Geologist whereby a sum not to exceed \$2,000 per year might be spent in North Carolina by the Federal Government, under the Weeks Law, for the employment of patrolmen and lookout watchmen in a definite scheme of fire protection organized and controlled by the State forestry authorities.

The Federal Government, however, has always required a certain amount of coöperation from the local landowners as well as from the State authorities before spending money to assist in this work. In order, therefore, to get the different interests together, and to arrive at some understanding which might result in getting this most important work started in North Carolina, the State Forester called a special conference on this subject to meet at Montreat, N. C., on the second afternoon of the Conference on Forestry and Nature Study. Western North Carolina lumbermen and other landowners, manufacturers using timber, railroad companies operating in that region, cities and towns, as well as interested associations, were invited and urged to send representatives. A good number accepted, as will be seen from the list of those present. The Federal Government's cordial coöperation in the program was of the greatest assistance.

The following account of the proceedings of the Special Conference is published for the information of those landowners who did not attend, yet who may be interested in coöperative forest fire protection, which is recognized as the most effective means of reducing the fire loss.

JOSEPH HYDE PRATT,
State Geologist.

LIST OF REPRESENTATIVES IN ATTENDANCE.

R. F. BREWER, Land and Industrial Agent, C. C. & O.	
Railway-----	Johnson City, Tenn.
B. E. RICE, Industrial Agent, Norfolk Southern Rail- way and John L. Roper Lumber Company-----	Norfolk, Va.
F. S. COLLINS, Southern Railway Company-----	Asheville, N. C.
A. S. GUERARD, Southern Railway Company-----	Asheville, N. C.
J. L. HATCH, Southern Railway Company-----	Salisbury, N. C.
F. STIKELEATHER, City Water Department-----	Asheville, N. C.
D. HIDDEN RAMSEY, City Water Department-----	Asheville, N. C.
G. S. POWELL, Appalachian Park Association-----	Asheville, N. C.
S. P. RAVENEL, Appalachian Park Association-----	Biltmore, N. C.
T. B. FINLEY, Timberland Owner-----	North Wilkesboro, N. C.
F. L. WINCHESTER, Champion Fiber Company-----	Canton, N. C.
G. L. WOOD, Montvale Lumber Company, R. E. Wood Lumber Company-----	Baltimore, Md.
B. H. STONE, Pfister & Vogel Land Company-----	Blairsville, Ga.
F. L. BLYTHE, Eastern Cherokee Indians-----	Cherokee, N. C.
F. M. PERLEY, Perley & Crockett Lumber Company----	Black Mountain, N. C.
J. W. CHURCH, Forestry Club-----	Tryon, N. C.
W. T. LINDSEY, Forestry Club-----	Tryon, N. C.
GEORGE B. COBB, Forestry Club-----	Tryon, N. C.
B. C. A. VON KAHLDEN, Forestry Club-----	Tryon, N. C.
WILLIAM M. HALL, U. S. Forest Service-----	Washington, D. C.
J. G. PETERS, U. S. Forest Service-----	Washington, D. C.
W. W. ASHE, U. S. Forest Service-----	Washington, D. C.
L. L. BISHOP, U. S. Forest Service-----	Marion, N. C.
J. J. FRITZ, U. S. Forest Service-----	Highlands, N. C.
R. F. HEMMINGWAY, U. S. Forest Service-----	Andrews, N. C.
VERNE RHOADES, U. S. Forest Service-----	Asheville, N. C.
E. P. BUSHNELL, U. S. Forest Service-----	Asheville, N. C.
JOHN RIIS-----	Winston-Salem, N. C.
JOSEPH HYDE PRATT, State Geologist-----	Chapel Hill, N. C.
J. S. HOLMES, State Forester-----	Chapel Hill, N. C.

ORGANIZATION OF COÖPERATIVE FOREST-FIRE PROTECTIVE AREAS IN NORTH CAROLINA.

CONFERENCE HELD AT MONTREAT, N. C.

Thursday, July 8, 1915, 3 P. M.

JOSEPH HYDE PRATT, Chairman.

PROCEEDINGS.

DR. PRATT: It may be well at the beginning of this conference to state briefly what the North Carolina Forest Fire Law really means to the State. It is the result of an educational campaign carried on by the North Carolina Forestry Association, the State Geological and Economic Survey, the various women's clubs throughout the State, certain township clubs, and others interested in forestry work.

The act authorizes the Geological Board to take up the proposition, or the problem, of protecting the forests from fire. While there is no direct appropriation made under this particular act, the Geological Board has an appropriation for forestry purposes, and from this appropriation we have been able to set aside a certain amount that can be used under this act; that is, used in connection with the carrying out of the purposes of this act.

Under this act the Forester appointed by the Geological Board (in this case, Mr. Holmes) is made State Forester and *ex officio* State Forest Warden. The board is also given authority under the act to appoint forest wardens who will have the same rights and powers as deputy sheriffs; in other words, they can make arrests without a warrant in carrying out the laws that have been passed by the General Assembly relating to forest fires. The State also has the right to require the services of men and teams to assist in fighting any fire that may be started. The act is liberal and broad in the power that it gives to the State Forester in connection with this work.

The wardens, patrolmen, and others must be paid for their services. The act regulates their compensation, but makes no appropriation for this purpose. In order to carry on the work and protect certain areas of our forests from fire, funds must be raised in some way.

Through the passage of this Forestry Act we are able to coöperate with the Federal Government under the Weeks Law, which we have not been

able to do up to the present time because we have had no State forest fire law. We have had laws relating to forest fires, about starting fires and extinguishing fires, but we have had no machinery whatever that could in any way enforce these laws. The new act gives the machinery necessary to enforce the laws that have been passed and that may be passed, provided we can raise sufficient revenue to pay the men that act as wardens and patrolmen under the authority of the Geological Board.

An agreement has been entered into between the Geological Board and the United States Department of Agriculture by which, under the Weeks Law, we will obtain from the Federal Government \$2,000 that can be expended in the protection of forests from fire; this amount being supplemented by \$2,000 from the Geological Board, which is to be spent in paying salary and expenses of the State Forester; in posting fire-warning signs, in educational work, and preparing publications relating to forest fires. Now, we want to supplement this amount, if possible, by contributions from individuals, from corporations, from railroads, and others who are interested in the protection of our forests. The chief reason for this conference today is to obtain your coöperation in this work of protecting our forests from fire.

I might as well state, at the outset, that there is no use taking what money we can raise—for it will only be a comparatively small amount—and trying to spread it out in a thin layer all over the forested areas of North Carolina, for if we do *we will not get results*. It seems to me, as we have considered the situation, that the best plan for us to follow is to take certain definite areas or districts to which a sufficient appropriation can be made that will insure putting into effect adequate measures for protecting these areas from fire.

Of course, the work will be done under the direct supervision of the State officials, but with the approval of the United States Forest Service. It means that the actual plan of work will be the same as has been inaugurated by the Forest Service in other sections of the country and in connection with the protection of their own lands in this State.

We have not as yet selected the areas to be protected; these recommendations will be by the Geological Board, and will have to be approved by the Forest Service. As yet, we have not made any recommendations as to what areas we shall start with in carrying out this system of protection of our forests, with the exception of the Mount Mitchell area, whose purchase was authorized by the General Assembly of 1915 and which will be a State forest. Outside of this, nothing has been decided upon, and as you can see, from the calling of this conference, it will depend largely on the support and coöperation that we can get from those interested in certain forested districts.

I think I am voicing the opinion of others in this State, of the members of the Geological Board (who considered this question at their semiannual meeting last week), as well as of members of the Forest Service, when I say that we wish, as far as possible, to obtain a few large areas to protect rather than a larger number of small areas. In other words, what we have to do and what we must do during the coming two years is to make such a showing in carrying out the provisions of the Forest Fire Act that when we go before the General Assembly in 1917 there will be no question whatever but that we will get an adequate appropriation for the protection of the forests of North Carolina. I believe it can and will be done. I see no reason why we cannot take certain areas and prove indisputably and definitely that the law can be made effective in the protection of the forests.

This afternoon I hope we can have an open discussion of the operation of the State Forest Fire Act, and also statements as to what you think can be done by you as representatives of certain sections in coöperating with us in carrying on this work.

MR. PETERS: Gentlemen, the part of the Weeks Law which relates to coöperation with States in forest-fire protection provides, first, that the protection must be confined to the watersheds of navigable streams; second, that the State must establish by law a system of fire protection; and, third, that the Federal Government cannot expend more money in any year than the State itself expends. The present total yearly appropriation for this coöperation is \$100,000.

North Carolina, through the law which Dr. Pratt has just explained, has met all three conditions. The State has requested coöperation, and the Government has agreed to allot to the State \$2,000. I am sorry that it cannot be more, but we are duplicating the State's fund, and that is as much as we can do. State Forester Holmes has been appointed a collaborator in the Forest Service and thereby given authority to employ men to do patrol or lookout work. Practically all of the Federal fund will be used for the hire of these men.

The State will offset the Federal expenditure by the portion of the State Forester's salary and expenses and the administration charges of his office which are properly chargeable to fire protection, together with such printing charges as may be incurred for publicity work in fire protection, that is, posters, fire notices like those Mr. Holmes has gotten out, and such notices as you see tacked up around this room, which with few exceptions are used by the Federal Service.

Unfortunately, the State has no funds for hiring patrolmen or lookout watchmen; so what we propose to do is to place Federal men of this

character on areas where the private owners themselves are taking or are willing to take an active interest. What I mean by active interest is actual coöperation in the form of hire of patrolmen, establishment of lookout stations, or other lines of work which show an expenditure of funds. Of course, we would want the owners to agree to pay the cost of any fire-fighting expense which may result from fires that start on their lands. Naturally, we do not want to place our men on areas where, if a fire occurs, they are unable to put it out for lack of funds. You can readily see the impracticability of that.

The work should be organized so that the area to be protected will be divided into patrol districts. I suppose it would keep one man fairly busy to patrol 10,000 acres in this region and do it thoroughly. This area he should subdivide into smaller districts, and appoint in each a man to act as foreman in time of a fire, whom he could rely on to get a crowd of men together and endeavor to extinguish the fire. Fires are reported by various means. The best we know of at the present time is the telephone. One of the most practical ways of securing quick notification here is for timber owners to extend their telephone systems up to lookout stations on prominent mountains. Federal watchmen might be placed there, and, when they discover fires, they can notify some one in the valley beneath. Thus considerable time would be saved. It all boils down to this: that in order to get effective protection you ought to be prepared, and you ought to plan your methods in advance. If you wait to act until the fire has started, somebody will get stampeded and a lot of mistakes will be made.

I think the best means that private timber owners can adopt to meet the danger from fire which is common to all in this locality is to organize a timber protective association. A number of such associations have been formed, and I wish to present for your consideration the numerous reasons for organizing one. We hear of coöperative societies being formed in various parts of the country to reduce the high cost of living. Why not organize a coöperative society or association in North Carolina to reduce the high cost of forest fires, that is, the large damage from forest fires and the cost of protection against them? This is not a new idea, and it is significant that wherever put into effect it has worked out successfully, and not one of the organizations has been discontinued.

Timber owners' protective associations were first established on a large scale in Idaho in 1906, and since then the movement has spread through the northern tier of States to the Pacific and Atlantic coasts, and is gradually reaching into the Southern States. Some forty associations of this character have been organized in the States of California, Oregon,

Washington, Idaho, Montana, Michigan, New Hampshire, Maine, Pennsylvania, West Virginia, and Kentucky. I think you will make no mistake by forming an association in North Carolina.

Thousands of acres in this State are covered with coniferous forests similar to those of the Northern States and West Virginia, and subject, as all of you know, to fires that sweep up into the tree-tops and destroy entire stands. In your hardwood forests the damage to merchantable timber is confined chiefly to the butts of the trees, which repeated fires leave scarred and hollow, thus making them much more liable to attacks from insects and fungi.

The loss from fire in this State has been enormous. Based on the statistics collected by your State Forester, which, I might add, are among the best available for any State, the average number of fires reported yearly for the period 1909 to 1913 is about 650, and the area burned over about 400,000 acres with a money loss of approximately \$450,000. But these are only present losses, those which are tangible. In addition, there are great future losses, including the destruction of small trees upon which depends the permanency of the lumber industry in this State; the deterioration of the soil and the forest; the crowding out of valuable timber trees by inferior ones; damage to water resources; interruption of business; and depreciation of property. Such losses can best be reduced by the organized joint effort of all interests concerned. As a means toward this end, I strongly urge you, gentlemen, to form a protective association.

As a rule, associations of this kind are organized as follows: Each has its by-laws and executive officers; a board of directors determines its general policies; a forester or chief fire warden supervises the field work. All timber owners are invited to join, from the large corporation to the owner of, say, 100 acres. Funds are raised by assessment on an acreage basis, from less than 1 cent an acre up. Usually each member, whether his acreage is large or small, has equal vote in association affairs. Patrolmen and other members of the field force are given police powers and authority to summon help to fight fires through appointment as township, county, or State fire wardens. I have here the constitutions and by-laws of some of these associations for your information.

The Coeur d'Alene Timber Protective Association in northern Idaho was the first of its kind to be organized, and its constitution has been the basis for practically all the associations which have followed. It is the one the West Virginia Association followed. I was fortunate enough to be on hand when that association was organized, and the owners adopted this constitution with the exceptions that the assessment was limited to

1 cent per acre per year and each member was entitled to one vote for every thousand acres, each being entitled to at least one vote, no matter how small his property. One of the Oregon associations requires a member to stand the expense of fighting a fire which occurs on his land, for the first 48 hours, before he can draw on the association fund.

So beneficial have been the results of coöperative effort that practically no member has withdrawn from an association. On the contrary, members are willing to contribute more liberally. At 1 cent an acre, a member would pay \$200 on 20,000 acres. Without organized protection he might spend that much fighting a single fire, not to mention his loss in timber burned and in shutting down his camps and mills. Under the association plan he not only has fewer fires and gets off cheaper, but escapes the worry also. I believe that through coöperative patrol and fire fighting the loss can be greatly reduced in your forests.

The cost would be small, considering the value of the property insured. I will give you some idea of the costs where associations have been formed. The Central West Virginia Fire Protective Association, representing 700,000 acres, began active operations in the fall of 1914 and expended during that period approximately \$2,837, as follows:

Field manager, or Chief Fire Warden, salary, 6 months	
@ \$125 -----	\$ 750.00
Expenses -----	437.59
Patrolmen's salaries and expenses -----	1,184.56
Printing, stationery, posters -----	61.68
Publicity work -----	66.00
Postage -----	23.24
Telephone construction -----	306.31
Miscellaneous -----	7.53
Total -----	\$2,836.91

Concerning the reduction of the usual fire loss in the territory of this Association, the report says:

"In discussing the work done, it is necessary to mention that the system of protection was given as severe a test during the past months of September, October, and November as could well be imagined. It happened that this fall has been the driest and most dangerous for fires of any that has been known in the State, and large destruction of timber has been reported outside of those sections under protection. In Monroe County, just south of the area in which we are interested, one fire is said to have covered twenty-five thousand (25,000) acres, with considerable loss; and in all of the counties there has been unusually heavy loss, despite the special effort that has been made this year by the State to keep down fire damage. In the Association area we have had forty (40) fires. Our men have fought some fifty-six (56) fires,

including twelve (12) that happened to start on adjoining land and were controlled before they reached us. The forty (40) fires burned over an area of 2,189 acres upon our land. Most of the fires were fought when they were small and stopped before they gained headway sufficient to cause great danger, and most of the fires started in brush or cut-over land and were stopped before they reached good timber. The loss is about two-sevenths of 1 per cent of the area protected. There are no definite records in previous years by which to compare this, but according to trustworthy report there has been an actual and large reduction in the area usually burned over, some placing it as high as 75 per cent. Thus, to reduce the normal area of fire damage in a year when all other regions suffered loss far above the average, should be sufficient proof that the system applied can produce the desired result, and should, in a normal year, result in a still smaller per cent of damage, which we hope to show in 1915."

The New Hampshire Timberland Owners' Association, with approximately 1,000,000 acres, expended in 1913 \$9,767.44, as follows:

Patrol	\$6,194.20
Mountain lookout station	150.57
Telephone account:	
repairs	102.92
exchange and toll expense	244.14
District chiefs	610.50
Advertising	68.27
Salary	1,500.00
Office expenses	396.84
Traveling expenses	500.00
	\$9,767.44

The Coeur d'Alene Timber Protective Association of Idaho, with 440,890 acres, expended in 1913 \$5,756.70, as follows:

Contribution to Western Forestry and Conservation Association	\$ 869.38
Telephone construction and maintenance	497.90
Salary of fire warden	1,200.00
Office expenses	283.98
Transportation	140.03
Cleaning out old trails	397.60
Six saddle horses	250.00
Patrolling	1,543.09
Fighting fires	187.07
Miscellaneous expenses	387.65
	\$5,756.70

Expenses will vary with the seasonal hazard. A skeleton force is maintained during normal seasons, which is increased as the danger becomes greater. Experience has demonstrated that the cost decreases as time goes on, because of increased respect for the fire laws and the addition of new members to the association. As a rule, at the start many timber owners do not join, and those who do have to pay for protecting the other fellow's land in order to protect their own. But gradually the delinquents come in, and so the pro rata is decreased.

The association exists primarily for actual field work, but it adds tremendous strength to the whole protective movement through its ability to educate the public and shape remedial legislation. A patrolman cautioning a logger or a hunter to be careful with fire, or prosecuting an offender, is immensely stronger with a broad, useful organization back of him than he would be as the employee of one timber owner. An association that can show its own liberal expenditure and practical results has an unquestionable right to suggest legislation and request appropriations for State work.

The chief advantages of association over individual effort are that responsibility is centralized, the work is systematized and conducted more efficiently, and the cost is kept at a minimum through lack of duplication of the various activities.

Gentlemen, I earnestly hope that we can all get together and coöperate in this work of fire protection in North Carolina.

I thank you very much.

DR. PRATT: I was very much interested in what Mr. Peters had to say in regard to these coöperative forest fire associations; that is, protective associations. It seems as though we could, here in North Carolina, divide the State into large districts and try to get the lumbermen in the districts to organize and coöperate with each other and the State and Federal governments, and thus get some pretty effective results in the protection of our forests from fires.

There is one point that I want to bring out, which I do not think Mr. Peters spoke of, and that is, if you organize without any relation at all to the State you have little or no authority in regard to the enforcement of any of the laws. In other words, your men may be patrolmen, but really not wardens; they have no legal authority. But if you coöperate with the State, the State Forest Warden, who is the same person as the State Forester, then has the authority to appoint, with the approval of the Geological Board, your wardens and your patrolmen, and they are given the authority authorized in the North Carolina Forest Fire Act.

So in that way the men who are going to be the patrolmen have the authority designated in that act.

There are several landowners in this State who have been protecting their lands and have obtained some pretty good results; their patrolmen have, however, insufficient authority. They have no way of bringing a man to justice without going out and getting some one to issue a warrant for him. If they were forest wardens, under this present act, they could arrest the man at once, and a few arrests, I think, would stop a great deal of the carelessness that now results in so many of our forest fires.

I would like to hear from all of you who are representing lumber companies, railroads, etc., your ideas as to the possibility of doing effective work through Forest Fire Associations in North Carolina.

The Conference is open.

MR. LINDSAY: I represent an organization, the Tryon Forestry Association, a club already organized for this very purpose, *i. e.*, forest protection. Our delegation comes here without authority to pledge any amount of money, and, in fact, without authority to make any pledge, but we delegates take it upon ourselves to pledge that we will fight the fires and pay all the expenses of fighting the fires, and not only that, but we will do all the missionary work possible in awakening the people to the necessity of fighting fires, provided the United States Government and the Geological Board will see fit to place a patrolman in Tryon Township. Tryon Township has about 10,000 acres of land to protect. I believe in a small area to protect. We do not want a county organization; we want a township organization, and I would ask for the respectful consideration of the appointment of a United States patrolman for Tryon Township.

I would like to state right here that we do not think it wise to appoint any local man for the fire patrolman. We would rather have a man with the United States Government seal upon him, a man with the right to make arrests and a man that would be perfectly unbiased and not afraid to arrest any man, whether he is kin to him or not.

I ask your respectful consideration of this appointment.

DR. PRATT: Mr. Hall, have you ever coöperated directly with railroads?

MR. HALL: I think we have. Possibly Mr. Peters knows more about it than I.

DR. PRATT: Mr. Peters, have you ever coöperated in any way with the railroads, and how can we get them particularly interested in coöperative fire protection?

MR. PETERS: The best examples I know of are those where the Forest Service is coöperating with certain of the western railroads, as the Northern Pacific and Great Northern, which own large areas of timberland in some of our National Forests. Agreements have been entered into with these roads whereby the companies will keep clear of inflammable material a strip of varying width, as conditions may demand, up to 200 feet beyond the right of way, and to provide all locomotives which do not burn oil with suitable spark arresters and other standard equipment to prevent the dropping of fire. The protected strip is designated jointly by representatives of the railroad and the Forest Service. The work of clearing the strip satisfactorily, including disposal of all slash and refuse, is done by the railroads under the supervision of the Forest Service.

The actual fighting of fires is also provided for. Prompt notification is given to Forest officers of all fires discovered by railroad employees. Telephone lines to make this possible have been put up by the Forest Service, using the companies' poles wherever desirable. Warning whistles are sounded by locomotives when fires are discovered. Forces of fire fighters are assembled on the outbreak of fires, made up of Forest officers, railroad employees, and such temporary labor as can be gathered by either. Except for salaries of regular employees, the cost of fighting fires which start within 200 feet of the railroad is borne by the company, and of all others by the Forest Service, unless it is shown in the first case that the railroads were not responsible, or, in the second case, that they were responsible for the outbreak of the fire.

You will be interested to know that the Forester recently had a conference with President Harrison of the Southern Railway on the feasibility of coöperating with that company.

MR. HALL: I will say, Dr. Pratt, in regard to the plan that we are trying to work out with the Southern Railway, that we have agreed with the company to send a man over the various lines this fall to study the situation carefully, with the idea of making some practical recommendations to the company in regard to controlling fires on their right of way, and especially relieving the company of the damages to which it is now subject on account of fires started by railroad locomotives. We are looking for a good deal to come out of that study, and will be very much disappointed if we do not get something out of it that will be useful to the company, and perhaps useful to other companies which may operate under the same conditions.

A RAILROAD MAN: All the railroad companies throughout the country are extremely interested in any laws or acts that are passed by any Gen-

eral Assembly of any State in regard to the protection of forests and the prevention of forest fires. When a forest fire occurs near a railroad, the origin of that fire is immediately laid to the railroad, whether it was the cause or not. If it starts close enough to the railroad, the railroad is given the credit of starting that fire, and I do not doubt that there have been many damage suits brought against railroads for forest fires which they never started at all. Unable to prove much one way or the other, the juries have given the man who brought suit the benefit of the doubt. The railroads are also interested in the general protection of the territory through which they pass.

A TRYON MAN: The Southern Railway passes right across Tryon Township, which brings up the question as to how this company can coöperate in making the work of our association more effective.

Right at a glance, there would seem to be several ways in which the railroad could coöperate. For instance, it might give instructions that crews of trains going up and down the mountain, if they see a fire just started, shall, as soon as their train reaches a telegraph station, telegraph to headquarters that there is a fire; the company might then telegraph to other places to get assistance in putting out the fire. Again, section men might be instructed to extinguish fires not only on the right of way, but on each side of it to a reasonable distance.

MR. BISHOP: Between the local Southern officials and the administration of the Mount Mitchell National Forest there has been very satisfactory and quite complete coöperation. The reporting of fires has been carried on quite satisfactorily, and there have been no fires along that portion of the right of way which passes from Ridge Crest east through the Mount Mitchell area. I do not think they have paid one dollar in damages on that right of way, though Mr. Hardwick tells me that previously he had paid enough in damages to own the land.

MR. COBB: May I say a word in regard to railroad and local coöperation? In Tryon Township the Southern Railway has coöperated with our club admirably. Four of the nine fires that have occurred since the Tryon Forestry Club went into existence, nineteen months ago, undoubtedly occurred from locomotive sparks, and the section men have turned out and worked and have helped us in every way possible. They were instructed by their superintendent, or whoever the man in authority was, that they should give attention to any alarm of fire started by their locomotives, or in the immediate vicinity of their right of way, and they have done royally well.

MR. AYRES: I was interested in following what has been said. We do not even wait for a telegraph station up our way. The engineer gives five long blasts of the whistle, twice repeated, and the section men and other railroad employees and all who hear the signal know that there is a fire just as soon as the engineer has seen it.

MR. POWELL: It seems to me that we have the nucleus here for two live protective associations. Tryon has an association, and that might be reorganized along the lines suggested by Mr. Peters, with a view to enlargement as new members would come in. Mount Mitchell also makes an ideal area for a protective association. The State will own a considerable area on the mountain itself, while the lumber companies own large tracts of land surrounding it. Getting down to practical business, it seems as though we could agree on an organization for the Mount Mitchell area. A board of directors might designate definitely the area to be included, though always keeping in view the possibility of enlarging it. It does not seem to me that it would be practical to organize a number of small associations, and handle them effectively.

Two members of the Asheville Water Commission are present, and I have no doubt that, after hearing this discussion, they will be glad to coöperate in an association as outlined by Mr. Peters.

MR. STIKELATHER: As a representative of the city of Asheville, I will supplement what Mr. Powell has said. We have 12,000 acres of land on the North Fork, and at present two wardens have care of that property. Naturally, the city of Asheville is in a somewhat difficult position for general fire protection. It has been necessary for us to fence our watershed to prevent cattle from ranging on it. In addition to this, we are now constructing a fire line around the larger part of the North Fork area. We have been forced to do this because the matter of fire protection for us is absolutely vital. That fire line will probably cost us more than the protection of 100,000 acres would cost under the plan proposed here; but, of course, you can see that fire protection is so vital that, in addition to the association that you gentlemen suggest, we must needs construct this for additional security. Our wardens naturally will coöperate with the wardens appointed by the Government or by the State, and if any concrete plan can be suggested by these various State and United States representatives by which a fire association can be organized, I shall be exceedingly glad to see that worked out. We will have to have an additional warden. I am wondering if a wire fence could be constructed around this property or if it would in any way work against fire protection generally.

MR. PETERS: I see no reason why it should. The only difference between your protection and the plan I have outlined is that yours is more intensive and a great deal better.

MR. STIKELEATHER: We have already had the coöperation of the United States Forest Service, and our men have coöperated with them. Of course, our men have other duties besides fire protection.

This protective insurance association that you suggest has interested me very much as an individual. It does seem to me that if an organization can be formed, charging, for instance, a premium of a cent an acre, it would work in Western North Carolina. There should be a warden in charge of the various properties, who would organize the work. He would visit and inspect the different parts of the area; would appoint patrolmen, and would organize a voluntary fire-fighting corps to be employed in the event of fire. There are probably fifty or one hundred large companies in Western North Carolina which are at present employing patrolmen. The expense of maintaining these men might be largely reduced if there could be some coöperation—a sort of voluntary fire department for service in the forest, such as is formed in cities where there is not enough money to support an entire paid department. If some gentlemen here can suggest a concrete plan by which such an association could be formed, there are, no doubt, many men here who would agree to pay the premium imposed, say, a cent an acre. I do not know how such an association could coöperate with the United States unless their patrolmen should have the same authority for arrest that is given to the United States wardens and the State wardens.

Speaking for Asheville, I have no authority to offer any sum from the city of Asheville to assist this movement. In regard to the Mount Mitchell area, I am satisfied that, in addition to the two paid patrolmen we now have and another we are placing on the Bee Tree Watershed, we might contribute additional funds for the work of patrolmen in that area generally. We now own almost exclusively the watersheds of Bee Tree and the various branches of the North Fork, which, with the additional areas that we will probably secure later, constitute approximately 18,000 acres. There are now 17,000 acres owned by the city of Asheville.

DR. PRATT: Coöperative forest protective organizations, which are virtually timber insurance associations, have proven feasible and practicable in other States, and I see no reason why there should not be an insurance association here for the protection of large timberlands, whether owned by corporations, lumber companies, or individuals. I should like to hear expressions of opinion from other owners. Mr. Winchester, what do you think of the general idea?

MR. WINCHESTER: I came here to learn, more than to give any instruction or information. My work has been largely devastation of forests, so far; but I want to get on the fence, or on the other side, to a certain extent.

My idea is to start this work and to start it quickly; to form an organization of the timber owners and other interested landowners in Western North Carolina, to prevent forest fires. The first work of that association should be a campaign of education and forest protection propaganda throughout the district. Then, on account of the wide territory over which the large timber interests are distributed, let them get up local organizations, for the time being, at least. That would be my idea of the most feasible plan at the present time, judging by what information I have picked up from those who are interested in the work. That starts the ball rolling. The company which I represent now owns only about 15,000 acres, and they are widely distributed.

DR. PRATT: What do you suppose you are paying out yearly now for patrol work?

MR. WINCHESTER: I could hardly tell you, because it has been quite widely distributed. We have given our foremen instructions whenever there is a fire started to take the necessary men to fight that fire. I have not investigated recently what the costs are or have been.

MR. WOOD: I concur with Mr. Winchester in his remarks. I came here for the purpose of learning the ideas of this meeting, rather than to suggest any. Our experience along the line of forest protection has been carried on solely by our own efforts. We are, in a sense, separated from other timber manufacturers, being located in the extreme western part of this State. Our area is quite large, and there are no active operations west of our holdings at this time. When forest fires have occurred, we have always taken care of them ourselves. It appears to me that in forming a forest fire association for the entire State of North Carolina it is undertaking too big a proposition. I think the State association should be subdivided into sections. We have a large State, and conditions in the eastern part are quite different from what they are in the Piedmont section, and conditions there are quite different from what they are in the western part. It seems, therefore, to me that each separate locality should be handled individually by subdivisions. I believe that more effective work and better results can be accomplished by local organizations, similar to what Mr. Lindsay spoke of as having been formed at Tryon. I believe that if some of the adjoining property owners would form small organizations they could more effectively main-

tain their patrolmen and watchmen by coöperating with the State and the United States Forestry departments. I do not think it is necessary to have lookouts employed the year around. The seasons of the year when the fires are most destructive occur during the spring and fall months. By maintaining patrolmen or watchmen during the dry seasons of each year, covering a period of four or five weeks in the spring and about an equal period during the fall, the danger season would be tided over. This, however, should be worked out on the association plan. Townships, if too large, should be subdivided and the patrolmen vested with the power to make necessary arrests. All fires should be reported promptly to the owners of the property. In order that no time shall be lost in reporting the location and size of the fire and in summoning sufficient men to control it, patrolmen should know where all available men may be found.

I believe that several small organizations will work to greater advantage than one State-wide one, because conditions vary so widely in the different parts of North Carolina.

MR. RAVENEL: I agree with Mr. Wood that this problem is essentially a local issue. There may be such communities as Tryon which will look after themselves, but for the most part the owners of lands who are willing to make some sacrifice for fire protection are widely separated.

But wherever there is National property, there exists already a system of forest protection with regular patrols, and this forms a nucleus for protection against fire. It seems to me that if the officers of the Federal Government and the State Government would formulate some terms upon which persons owning adjacent lands could come in for the same protection, that is, enlarge the scope of the plan already existing by adding to the area which has the benefit of fire patrol, a great many land-owners would comply with those conditions.

I know that in some of the areas the fires have been greatly diminished. In the region about Highlands, where I own timberlands, it has been marvelous the extent to which forest fires have been reduced, and there has been a good deal of voluntary work on the part of the Government officials in putting out fires which have not, in all instances, been on the Government property, but, of course, were a menace to their property.

We have with us one of those officers, who has made a brilliant record as a fire fighter, and I should like very much to hear from Mr. Fritz. I do not think any one could enlighten us more, and perhaps he can formulate some scheme along this line.

MR. FRITZ: I am afraid that Mr. Ravenel rather flattered me. Ever since I have been in the district to which he referred, I have felt the need of some coöperation with the private landowners. There are several small holdings, which lie adjacent to some of the Government lands, that should be protected, and indirectly are protected by the Government at the present time, but it is believed by our forest officers that the private owners should bear a part of the expense. It is hoped that from the results of this meeting we will be able to plan some well defined system by which we can coöperate in the protection of those lands.

MR. PERLEY: My situation is about like that of the Champion Fiber Company, as you will see if you take the trip over our logging railroad to Mount Mitchell. Patrol work is done by us only in the very dry season. We have been very successful this year and have not had any fires at all.

MR. PETERS: I would like to state for Mr. Wood's information that although I said nothing about the protective work being conducted only during the danger period, that was understood.

MR. FINLEY: I am just studying, thinking, and comparing ideas with the rest of you gentlemen. I do not know, but it appears to me that we could work out a system something like this: Let us have local associations, as suggested, and let them coöperate with the State and the Federal Governments, the expenses of the local association to be borne partly by the United States, partly by the State, and partly by the local owners. In other words, let it be mutual all the way around. If the owners paid all the expense, possibly they might think it was a little too hard; and if the State has enough money it could pay part. The United States, of course, could pay anything it wants to, but it does not want to make the State feel badly; therefore, it does not pay more than the State pays. Of course, the owners are not able to pay much, because many of them are land-poor. Therefore, it seems to me that the coöperation ought to be all around.

Now, my county, the county of Wilkes, or rather the "State of Wilkes," as it is often called, has an area of about 700 square miles. A large timber company in the west end of the county owns 60,000 acres, while one in the east end of the county has 24,000 acres. In addition to this, there are smaller properties needing protection in this and near-by counties amounting to 25,000 or 30,000 acres more, while many small tracts all along the Blue Ridge might be brought in. Here might be a local organization. The large owners generally have men looking after the timber. They have men to look after fires, trespass, and all sorts of business; in

other words, they look over the land every few days. But if this fire protection was combined with the general forest supervision it would be a great feature, it strikes me, and hundreds of thousands of dollars would be saved every year by having it properly looked after, with the Government and the State behind it.

MR. AYRES: I would like to say that the plan up our way has worked out exactly as he said, although we do not share expenses just as the gentleman mentioned, but the three forces do work together.

MR. PETERS: Mr. Chairman, referring to what Mr. Finley has just said, as I understand it, each company he referred to has a man to do work of a protective character. Now, it might be possible to effect a combination so that if, for example, there were five concerns, employing five men, the combination, or association, if you please, would employ only three men, thus cutting down the cost of the work by the amount paid to two men. That is one of the very practical features of the association plan.

MR. HOLMES: I want to ask Mr. Finley a question. I have had a letter from Mr. Smoot; I have been in close correspondence with him for a while, and I think his is one of the large companies that you speak of?

MR. FINLEY: He is one of the largest and owns quite a good deal of land.

MR. HOLMES: Mr. Smoot has promised close coöperation in fire protection. Now, what I wanted to ask was, Do you know of any other landowners who would come in on any close coöperative scheme in the way Mr. Smoot will, so that we can start an area in Wilkes and Surry counties?

MR. FINLEY: I am satisfied that we could start a local organization if Mr. Smoot would coöperate; and then if we could get the Grandin Lumber Company in with the 60,000 acres, it would be quite an addition. The company with the 24,000 acres, which already has this kind of supervision to some extent, might also be brought in. But I am satisfied we would be able to have one or two organizations, whichever is feasible. Whether it would be better to have one or two organizations is a matter to be worked out, but I am satisfied that we could certainly have one right in the center. Some time ago, with the advice of the North Carolina Geological and Economic Survey, we organized the Wilkes County Forest Protective Association, but it has never done any real protective work.

MR. HOLMES: I understand that the Grandin Lumber Company is not in a position to take this matter up just at the present time. I trust that they will come in, however, in the near future.

What we want to do is to start fire protection this fall—if possible, by the middle of September. We want to get just a nucleus, if it is only two or three contiguous landowners. The idea is to get some definite point from which we can work up a coöperative area so that one or more patrolmen may be appointed on several different areas during the fire season this fall.

MR. ASHE: Since you must have a nucleus to work upon, why could not this meeting adopt a plan for the State and the Government to coöperate with any two or more adjoining or near-by owners who have an aggregate area of not less than 10,000 acres, making that acreage the minimum area for coöperation and a local association? Any timberland owner in the State might seek coöperation with his neighbors in order to secure the necessary acreage, and the assessment cost of patrol should not exceed 1 cent an acre. The Chief State Fire Warden should have the power to appoint the patrolmen, who would be State officers, having power to arrest, their salary being fixed by the Federal Government. Each such local association could have the right to have a delegate to the central association. That would create local organizations, give local self-government, and make local interest. Such a basis would serve at the start, and would give any one an opportunity to form a local association. There might be several such associations in the vicinity of Asheville. Mr. Finley could start one or more in Wilkes County. He would have some assurance of success. If another association were started in Mitchell County, that would be another nucleus even if only two owners entered it. There should be at least two owners, so that it would not be a personal matter. One owner should certainly be able to interest a neighbor; or three owners might be made the minimum. It seems to me that there would be a possibility of working up quite a number of local organizations in this way.

MR. PETERS: I think Mr. Ashe's idea is all right. Personally, I would not go quite so far at the beginning. My idea would be to encourage the organization of an association in an educational way. I do not believe that you can effect an organization of timberland owners for the whole of western North Carolina at this meeting. I think the interests represented here are too far separated; but I do think that you gentlemen who are interested—and I hope all of you are—can work up sentiment among your neighbors and in that way endeavor to form a combination.

For the present, we should not hesitate to coöperate with the individual owner. Of course, where two or more owners can be brought together that would be preferable to individual coöperation. But rather than not coöperate at all, I think we should go ahead and start with the individual.

The idea would be to coöperate with the owner who will in good faith show interest in the work and give a reasonable amount of attention and funds. If a neighbor wishes to do likewise, combine with him; and if another wishes also to come in, we have a combination of three; and so on. What we want is to get something started. I am firmly convinced that if we get started the work will progress as a result of its value being demonstrated.

MR. AYRES: I make a suggestion now, which possibly might be put in the form of a resolution: that an account of this Conference be drawn up by the State Forester, with an announcement of the plan of organizing local district protective associations, such as have been suggested, of two or three or a number of landowners, and expressing the willingness of the State Forester and the Federal Government to coöperate where such associations can be organized, and that he issue that information by letter or circular to as many timberland owners as he can get in touch with in the State.

Motion seconded and carried.

DR. PRATT: We shall have to bring this Conference to a close, but before we do, I want to say that the Geological Board and the United States Forest Service would like very much for any one here representing corporation or individual landowners, who wishes to consider this coöperation between the Federal Government, the State, and themselves, to see Mr. Holmes or Mr. Peters before they go away. We can then, perhaps, get something started, and we will find out what they can do or will do.

When you go back home and take the question up with the people in your district, you can get them to promise coöperation, and then take the matter up with the Geological Board at Chapel Hill. Final arrangements can then be made for organizing a coöperative fire protective area.

If any of you here will take up this question before we go, arrangements can probably be made for either a State or Federal forest officer to visit your section, look the ground over and make suggestions regarding what form of coöperation can be taken up and put into effect.

Following the conference, some informal discussions with certain possible members of proposed associations were held. As a consequence the following suggested plan of organization was drawn up. This is now being submitted to the various landowners concerned for their approval.

This outlined plan can, and undoubtedly will, be changed in many minor details, but probably not very much in its essentials. It is given here as a good example of the kind of coöperation which is proposed between timberland owners, the State, and the Federal Government.

A PROPOSED WORKING OUTLINE FOR THE SUGGESTED MOUNT MITCHELL FOREST PROTECTIVE ASSOCIATION.

OBJECT.

To protect the lands, timber, and other property of the members from fire. The present plan includes the fall fire season of 1915. Runs to December 31, 1915.

MEMBERS.

Any firm, corporation, or individual owning property within the area to be protected may become a member by signifying his or their willingness to comply with the hereinafter set forth conditions. The policy to be to extend the influence of the Association over as great an area as possible. Persons owning as much as one hundred acres of land should be encouraged to join.

ORGANIZATION.

Field work to be in charge of the supervising forest officer of the Mount Mitchell purchase area. He to be known as Chief Warden and to be appointed Township Forest Warden by the State of North Carolina. Service rendered without cost to the Association.

Under the Chief Warden, and also appointed Township Forest Wardens by the State, will be:

a. PATROLMEN (5). To spend time patrolling their districts, put out such fires as they can, give immediate information as to others, at such times during the danger season as is practicable, spend time building trails, etc. Paid by day, week, or month.

Districts.

No. 1. From Perley & Crockett Mill to Pinnacle Ridge. Should stay at Long Gap. Phone available. Should probably be Buncombe County man. Black Mountain Township.

No. 2. From Pinnacle Ridge to north end of Perley & Crockett operation on east side of the Black Mountain. Should stay at camps near commissary. Handy to phone. South Toe Township.

No. 3. Perley & Crockett operation on west side of ridge. Should live at Camp No. 9. Phone available. Pensacola Township.

No. 4. Swannanoa Township and to Ridge Crest. Mainly along north side of Southern Railway.

No. 5. Big Ivy and Shope Creek District (under Federal patrolman).
Big Ivy Township.

b. FOREMEN. To be appointed District Forest Wardens to take charge of fire fighting when a fire occurs that cannot be put out by patrolman. Should be several for each district, if available. Each should be assigned a subdistrict. To be paid a retaining fee of \$5 per year in advance and then by the hour for time actually spent fighting fire at the rate prevailing in that locality for such services, but not to exceed 20 cents per hour. To be appointed District Forest Wardens. Must know how to fight a fire and how to handle men.

ESTIMATE OF COSTS.

September, 1915, to January 1, 1916.

I. General Expenses:

Patrolmen, 4 at \$45 per month, 2 months-----	\$360.00
Foremen, 10 at \$5 each-----	50.00
Emergency fire fighting and general fund-----	200.00
Total -----	\$610.00

II. Improvements:

1. Trail, Bald Knob to Potato Knob, 2 miles-----	\$400.00
2. Trail, Mount Mitchell to Potato Knob-----	75.00
3. Tool boxes, supplied with tools, 6 at \$20 each-----	120.00
Total -----	\$795.00

Explanation of above items not already taken up in detail:

General Expenses:

Emergency fire fighting and general fund-----\$200

This fund would provide for the costs of fighting any fire which burned on land not included in the Association. Such fires would be fought only if they endangered the land of the members. Also provide for any general expenses.

Improvements:

1. Trail, Bald Knob to Potato Knob-----\$400

This trail is needed as a means of communication and as a fire-break. Would be of great value to the Federal Government in connection with the administration and protection of their land; of great value to the city of Asheville in connection with the protection of their watershed, and of much value to the public generally, especially the Montreat Association and town of Black Mountain. Would benefit Mr. Dunn greatly.

Should be built at once. All equipment can be supplied by the Forest Service. Should be 3-foot trail; 10 per cent grade, well drained, free from loose rock, carefully located.

2. Trail, Mount Mitchell to Potato Knob-----\$75

There is a poor trail over this distance now. It should be worked over again. Is full of logs, laps, etc. Would be of great general value as a patrol line and means of communication.

3. Tool boxes filled with tools, 6 at \$20 each-----\$120

One of the first things in fire protection is to have suitable tools available.

Each box should contain :

Boxes located at :

2 axes.	Long Gap.
2 mattocks.	Where first commis-
2 lanterns (filled).	sary was.
3 water pails.	Rock Creek.
2 water bags.	Stepp's Gap.
12 potato hooks.	Under Rainbow Gap.
1 cross-cut saw.	Swannanoa Township.

List of Probable Members and Property Owned by Each.

NAME.	ACREAGE.	REMARKS.
Brown Brothers-----	3,000	Stumpage owned by Dickey & Campbell.
Highland Spruce Company----	9,000	Stumpage under contract to Dickey & Campbell and Perley & Crockett.
City of Asheville-----	17,000	Largely under protection at this time. Only about 2,000 acres would come under the influence of this plan.
Montreat Association-----	4,000	
Burke Tanning Company-----	2,000	
Bee Tree Lumber Company----	3,000	
United States-----	10,000	
Small tracts-----	3,000	—or so. Several on Mineral Fork which will no doubt come in.
Total-----	51,000	

DISCUSSION OF PROBABLE MEMBERS.

Brown Brothers. By a protective association this firm would profit inasmuch as they own the fee in the 3,000 acres of land upon which Dickey & Campbell own the stumpage. This stumpage is now being operated by Perley & Crockett. Thus in the protection of the spruce belt of the Brown Brothers tract, three companies are benefited.

Highland Spruce Company. This company owns the land and stumpage. The softwood stumpage is under contract to Dickey & Campbell

and is relet by them to Perley & Crockett. In the protection of this tract three concerns would be benefited.

City of Asheville. While the city owns some 17,000 acres in the locality covered by this plan, the most of their land is under adequate protection at this time, and they should not be asked to contribute funds on the basis of all they own. Some several thousand acres of their land, however, can be best protected in connection with the lands covered by this plan.

Montreat Association. The portion of this property which is most apt to burn over is the part along the logging railroad. This can be protected very advantageously in connection with the Burke Tanning Company land just across the Blue Ridge.

Burke Tanning Company. Two thousand acres on Mill Creek. Burns over nearly every year. Can be protected in connection with the Montreat lands.

Bee Tree Lumber Company. Three thousand acres on Revis Creek. Virgin timber land. Can be handled together with the Big Ivy tract. R. B. Brank should be appointed foreman.

United States. Big Ivy tract, Burlison lands on North Fork of Ivy, Dr. Ambler lands and Ward & Nichols tract.

Small Tracts. Owned by several parties in Swannanoa Township principally.

Table Showing Estimated Expenses and Suggested Apportionment Among Members.

	City of Asheville.	Brown Brothers.	Highland Spruce Company.	Dickey & Campbell.	Perley & Crockett.	Montreat Association.	Burke Tanning Company.	Bee Tree Lumber Company.	United States.	State and Federal Aid.	Any Other Source.	Total.
Amount owned—acres—	*17,000	12,000	owned jointly.			4,000	2,000	3,000	9,500	-----	3,000	50,500
LIST OF EXPENSES.												
Trail—Bald Knob to Potato Knob.....	\$ 100	\$---	\$---	\$---	\$---	\$ 50	\$---	\$---	\$200	\$---	\$ 50	\$ 400
Trail—Mount Mitchell to Potato Knob.....			10		10				25		30	75
Tool boxes.....	20	5	20	20	20	5	5	10			15	120
General expenses.....	50	20	50	80	120	25	25	25		125	90	610
Totals.....	170	25	80	100	150	80	30	35	†225	125	†185	1,205

*Includes Bee Tree tract, which is just now being acquired by the city.

†In addition to furnishing the patrolman on the Big Ivy District.

‡This amount would have to be raised largely in Swannanoa Township or from the Weeks Law fund.

CONDITIONS.

Each member to subscribe toward maintenance of the Association according to the benefits derived. Chief Warden to suggest apportionment of expenses. In case of a deficit, an assessment to be made in proportion to original subscription. Each member to pay for putting out fire on his or its land or caused by him.

Expenditure of funds to be subject to the approval of the Forestry Board of the State on the order of the Chief Warden.

Spark arresters inspected each day and report sent owner. Inspected by Chief Warden from time to time. Trainmen to put out any fire seen. If help is needed, blow for section men.

Tools should be carried on each engine.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*
8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*
15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*
16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*
17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*
22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, 1915. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents.*

25. Zircon, Monazite, and Other Minerals Used in the Production of Chemical Compositions Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D. *In press.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virginian, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nerst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of

Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Prof. Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina During 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties, with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a List of Gems and Gem Minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems occur, as taken from United States Geological Survey Report, by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin, and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos, describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin Mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31 and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey—Statistical Report of High-

way Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer. 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of the Seventh Annual Drainage Convention held at Wilson, N. C., November 18 and 19, 1914. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. 8°, -- pp. *In press.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary. *In press.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley, 1915. 8°, -- pp., 30 pl., 262 figs., 1 map.

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp.
Postage 1 cent.

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp.
Postage 1 cent.

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp.
Postage 2 cents.

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declinations at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorne, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

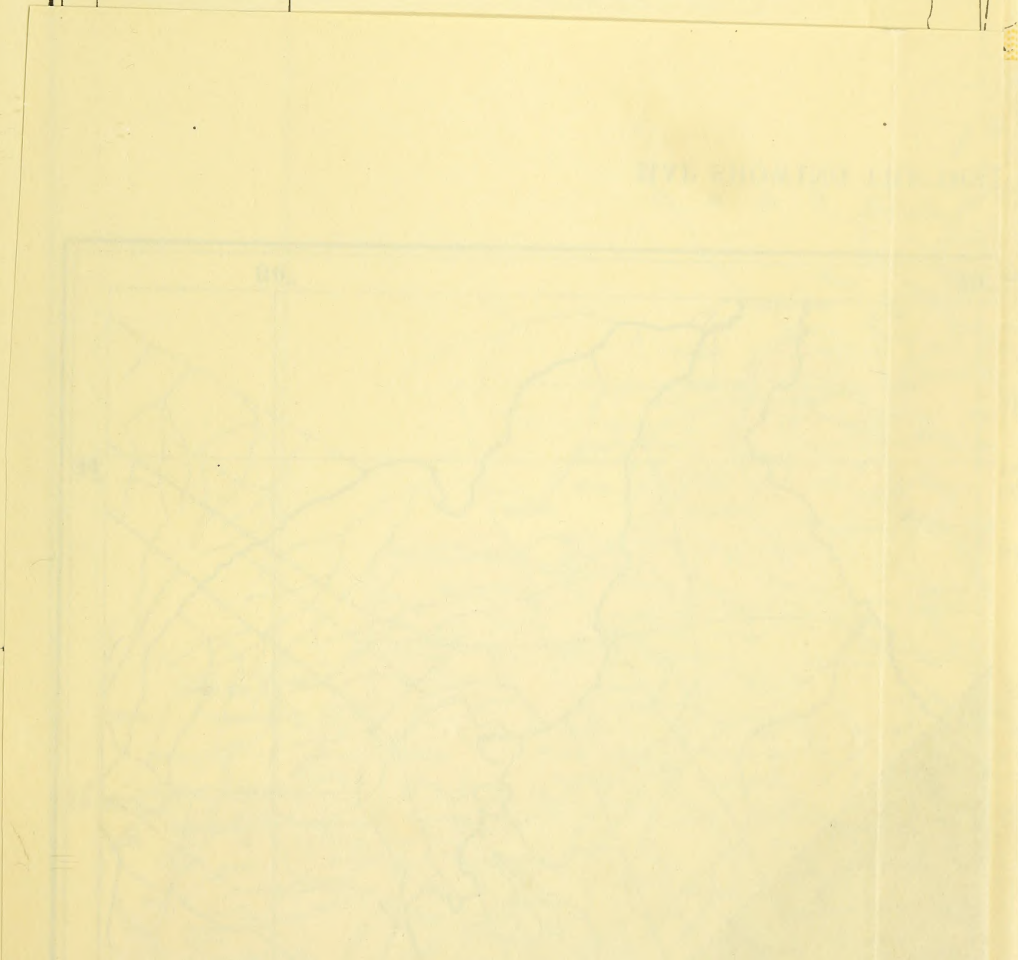
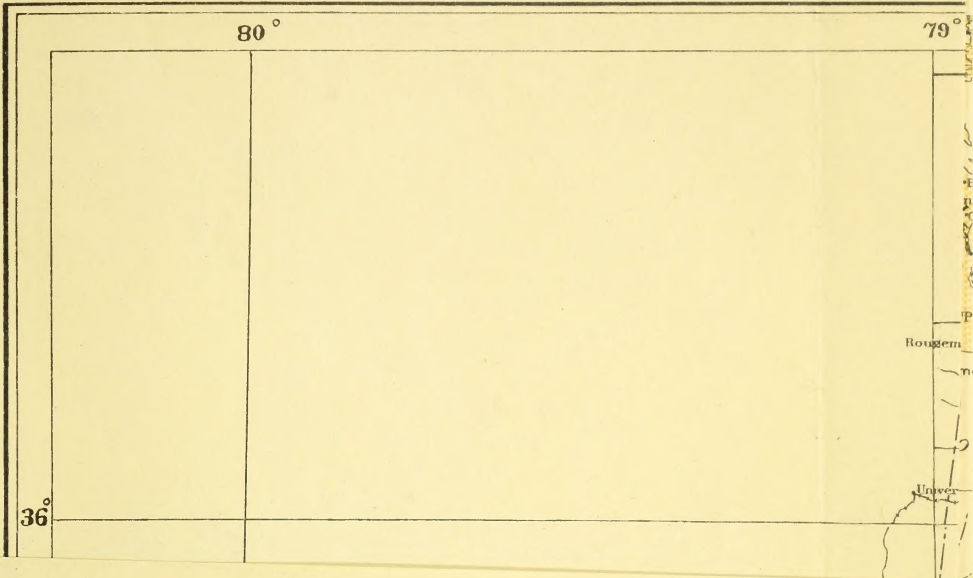
Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

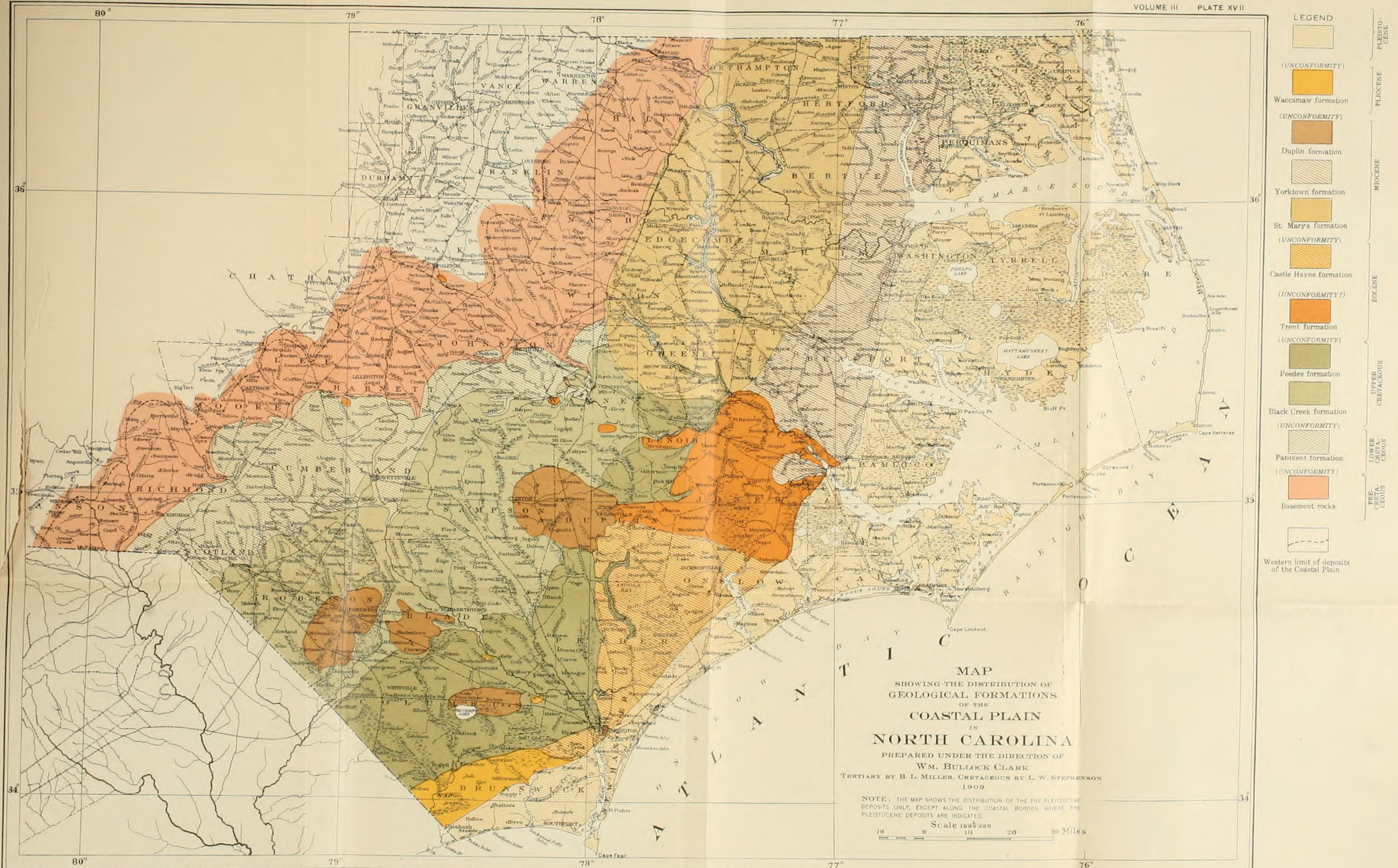
Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the U. S. Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on forest fire conditions in the southeastern States, by J. S. Holmes. Report on the work of the U. S. Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

N. C. GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT, STATE GEOLOGIST





MAP SHOWING THE DISTRIBUTION OF GEOLOGICAL FORMATIONS OF THE COASTAL PLAIN OF NORTH CAROLINA, EXCLUSIVE OF THE SURFICIAL FORMATIONS.

80°

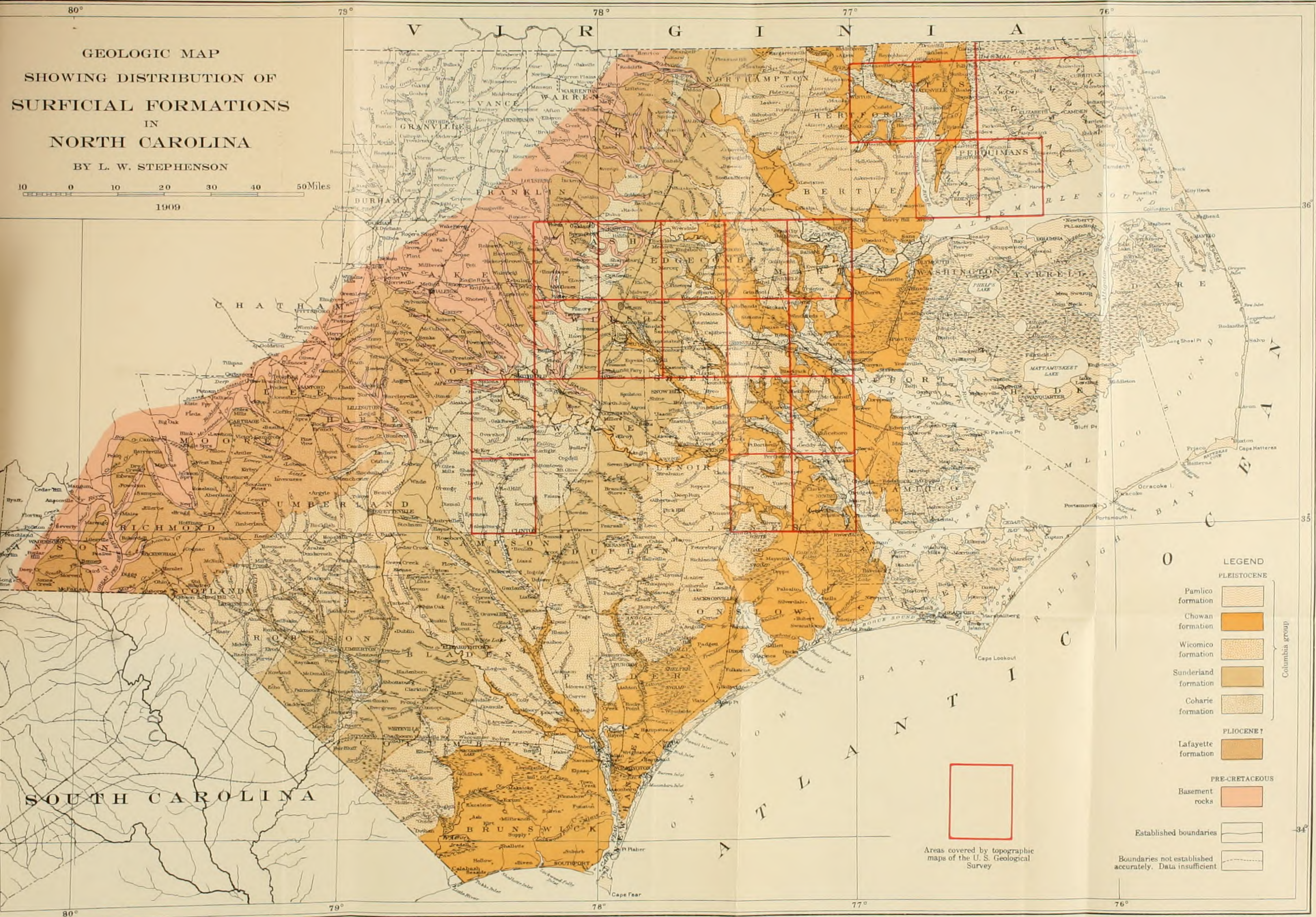
79°

GEOLOGIC MAP
SHOWING DISTRIBUTION OF
SURFICIAL FORMATIONS
IN
NORTH CAROLINA

BY L. W. STEPHENSON

10 0 10 20 30 40 50 Miles

Bouguer



GEOLOGIC MAP SHOWING DISTRIBUTION OF SURFICIAL FORMATIONS IN NORTH CAROLINA.

